LIVERPOOL

GEOLOGICAL ASSOCIATION.

JOURNAL.

VOLUME VIII.

SESSION 1887-8.

LIVERPOOL:
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1889.

LIVERPOOL

GEOLOGICAL ASSOCIATION.

ESTABLISHED 1880.

ANNUAL REPORT,

1887.

LIVERPOOL GEOLOGICAL ASSOCIATION,

FREE LIBRARY, WILLIAM BROWN STREET, LIVERPOOL.

Established 3rd June, 1880.

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Council:

PRESIDENT:

A. NORMAN TATE, F.I.C., F.C.S.

VICE-PRESIDENT:

REV. S. GASKING, B.A., F.G.S.

MEMBERS OF COUNCIL:

I. E. GEORGE, T. S. HUNT,

W. H. MILES, C. E. MILES,

J. BROWN.

TREASURER:

T. R. CONNELL,
Melville Chambers, Lord Street, Liverpool.

SECRETARY:

D. CLAGUE,
81, Lime Grove, Liverpool.

The above form the Executive.

Librarian: E. EVANS.
Superintendent of Excursions and Editor: I. E. GEORGE.
Registrar: C. F. WEBB.

———:o:———

DEPARTMENTAL REFEREES:

Palæontology - - -	Rev. S. GASKING, B.A.
Microscopy - - -	I. E. GEORGE.
Mineralogy - - -	D. CLAGUE.
Chemical Geology - -	THE PRESIDENT.

Liverpool Geological Association.

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ANNUAL REPORT.

SESSION 1886-7.

3rd OCTOBER, 1887.

During the past year 14 new members have been elected, 9 have resigned, and 27 been removed for non-payment of subscription. With regard to the latter, the attention of the Council has been drawn to the fact that for some years past there have been on the books the names of many persons who neither attended the meetings nor paid subscriptions, and it has been resolved to enforce the provisions of Rule 3, and consequently all persons whose subscriptions were three years and over in arrear have been struck off. Although this may have reduced the list of names in the roll of members, it only more truly gives a statement of the effective strength of the Association. The present number of members is 114.

During the year we have had 11 ordinary meetings, at which the following papers were read :—

Nov. "Geological Technology," by the President.

Dec. "Geology of Rouen," by the Rev. S. Gasking, B.A., F.G.S.

Jan. "Sand Dunes of Cheshire Coast," by C. Potter.

Feb. Lantern Views of Wales, Ireland, and Channel Isles, which were described by the President, I. E. George, and D. D. Pritchard.

March "Wind Erosion," by I. E. George.

April. "Action of Water in forming Rocks and Minerals," by H. T. Mannington.

May. "Geological Ramble in the Isle of Man," by P. H. Marrow.

June. "Notes on the Geology of Deganwy," by T. Mellard Reade, C.E., F.G.S.

July. "The Mersey Estuary," by C. E. Miles.

Sept. "Use and Abuse of Stones in Building," by J. Wilding.
"Weathered Rocks at Hilbre," by I. E. George.
"Fossil Teeth," by C. F. Webb.

In addition to these ordinary meetings the members had an opportunity, on October 8, by the courtesy of Mr. Isaac Roberts, F.G.S., of studying Lunar Volcanoes, at his Observatory at Maghull; and the following meetings were held at the Free Museum, William Brown Street :—

Dec. 18.—"Study of Iron Ores," conducted by H. T. Mannington.

Jan. 15.—"Study of Life of the Lias Period," by D. Clague.

Feb. 19.—"Coal Fossils," by Rev. H. H. Higgins, M.A.

Mar. 19.—"Silica Minerals," by C. E. Miles.

There were seven Field Meetings, viz. :—

Apr. 18.—Easter Monday. Field Meeting at St. Helens, conducted by Rev. S. Gasking, B.A., F.G.S.

May 14.—Visit to Chester, including visit to Grosvenor Museum of Natural Science, conducted by W. Shone, F.G.S.

May 20.—Whit Monday. Field Meeting at Hilbre Island, conducted by I. E. George.

June 15.—Field Meeting at Leasowe, conducted by C. Potter.

July 12.—Field Meeting at McFall's Quarry, Green Lane, conducted by I. E. George.

Aug. 1.—Bank Holiday. Field Meeting at Castleton, conducted by Dr. Ricketts, F.G.S.

Sept. 10.—Field Meeting at Thatto Heath, conducted by D. Clague.

These meetings have all been very instructive, and their success is mainly due to the excellent arrangements made by the Superintendent of Excursions, Mr. Isaac E. George.

A series of meetings were also held in the President's Laboratory in the early part of the year, for the study of Micro-Chemistry applied to Geology.

The LIBRARIAN reports that the Library continues to be well used, and it now numbers 110 books.

Several valuable donations of Books call for thanks to the Donors—Dr. Ellis, A. Norman Tate, F.I.C., &c.; G. H. Morton, F.G.S.; Rev. H. H. Higgins, M.A.; Dr. Ricketts, F.G.S.; J. C. Evans, and the Department of Mines, Victoria, and the Mining Bureau of California.

Our Collection of Maps has been enriched by handsome donations of Maps of the Gold Mines of Victoria, and the Geological Survey Maps of our own district on the 6 in. scale, for which our thanks are due to the Department of Mines and our President respectively.

The Council desire to express their thanks to the Librarian for the attention he has given to his duties.

TRANSACTIONS have been exchanged with the following learned societies:—

Belfast Naturalists' Field Club.
Burnley Literary and Philosophical Society.
California State Mining Bureau.
Chester Society of Natural Science.
Cornwall Royal Geological Society.
Cornwall Mining Association and Institute.
Lancashire and Cheshire Entomological Society.
Leeds Geological Association.
London Geologists' Association.
Liverpool Astronomical Society.
Liverpool Engineering Society.
Liverpool Geological Society.
Liverpool Literary and Philosophical Society.
Liverpool Naturalists' Field Club.
Liverpool Polytechnic Society.
Liverpool Science Students' Association.
Manchester Geological Society.
Manchester Science Students' Association.

Nottingham Naturalists' Society.
Smithsonian Institution, Washington.
Victoria Department of Mines.
Yorkshire Philosophical Society.

Copies of Transactions have also been sent to several other societies, from whom it is hoped to receive their Transactions in due course.

The Transactions for the current year are completed, and are in the hands of the members. It will be seen that for several months past some additions have been made to them in the shape of Monthly Notes and other short articles. This alteration has been much approved both by our own members and others who have had the opportunity of seeing them, and it now remains with our members to say whether these additions shall be continued; if so, increased contributions will be needed, as the ordinary income of the Association will not bear the expense.

A pleasant feature in last year's work is the great attention which was devoted to matters of local interest, and it is hoped that this will be continued during the ensuing year.

At a Special Meeting of the members it was resolved to alter our rules so as to admit a class of Honorary Members, which shall consist of gentlemen who have done good service to geological and kindred sciences.

The Financial Statement appended is satisfactory as showing that, notwithstanding heavier expenses than usual, the Association has been worked economically, is out of debt, and has a balance in hand of £2 14s. 4d.

LIVERPOOL GEOLOGICAL ASSOCIATION, in Account with the Treasurer,

FOR YEAR ENDING SEPTEMBER, 1887.

Disbursements.

1887.		£	s.	d.
September.	To Rent of Room and Attendant.....	3	5	0
	,, Printing and Stationery	25	3	6
	,, Postages and Incidentals.....	9	9	4
	,, Balance in Treasurer's hands.....	2	14	4
		£40	12	2

Receipts.

1886.		£	s.	d.	£	s.	d.
Sept.	By Balance from last Account ...				5	19	2
1887.	,, Subscriptions, viz. :—						
Sept.	114 Members at 5/-.....	28	10	0			
	5 Members paid in advance in previous years £1 5 0						
	24 Members in arrears 6 0 0						
	—	7	5	0			
	29						
	85 Subscriptions for 1886-7	21	5	0			
	2 ,, 1883-4	0	10	0			
	5 ,, 1884-5	1	5	0			
	25 ,, 1885-6	6	5	0			
	3 ,, 1886-7	0	15	0			
	120				30	0	0
	,, Receipts from Members for Printing ...				4	13	0
					£40	12	2
	By Balance				£2	14	4

LIBRARY FUND.

By Balance as per last Account	£0	11	6

Audited and found correct,
G. WATSON GRAY, A.I.C., } AUDITORS.
JOHN MORRIS, }

THOS. R. CONNELL,
TREASURER.

Liverpool, 29th September, 1887.

LAWS

OF THE

Liverpool Geological Association,

ESTABLISHED 3rd JUNE, 1880.

OBJECT.

The object of the LIVERPOOL GEOLOGICAL ASSOCIATION is to promote the study of Geology and its allied Sciences.

RULES.

I.

That every Candidate for Ordinary Membership shall be proposed and seconded by two members of the Association, and balloted for at the next Ordinary Meeting; and the consent of three-fourths of the members then present shall be necessary for the admission of such Candidate.

The proposal shall be made on Form A, which must be filled up and lodged with the Secretary one week before the meeting at which the Candidate is to be proposed. The proposal form shall be submitted to the Council, and the Secretary shall report to the members any remarks the Council may deem it expedient to make thereon.

II.

Every Ordinary Member shall pay an annual subscription of Five Shillings, payable on the 1st October, or, in the case of a new member, within one month after election. Any member not paying the subscription within three calendar months, after being twice informed by the Secretary that it is due, shall no longer be considered a member of the Association.

III.

There shall be a class of Honorary Members, not exceeding ten in number, which shall consist of persons distinguished by their attainments in the study of Geology and its kindred sciences, or who have rendered valuable service to the Association.

Such Honorary Members shall be nominated by the Council and elected by a majority of votes at an ordinary meeting, and have all the privileges of Ordinary Members.

IV.

The Officers of the Association shall be a President, Vice-President, Treasurer, Secretary, and five other members, who together shall constitute the Council to manage and direct the affairs of the Association. Five to form a quorum. The officers shall be elected at the Annual Meeting to be held in October; retiring officers shall be eligible for re-election. Any vacancy occurring during the year shall be filled up by the Council.

V.

The Treasurer's Financial Statement shall be presented to the Association, with the Annual Report, after having been duly audited by two members proposed, seconded and elected at the last meeting of the Session.

VI.

The Ordinary Meetings shall be held on the first Monday in each month, at eight o'clock in the evening. The order of proceeding at such meeting shall be:—

1.—The ordinary business of the Association.

2.—Miscellaneous Communications.

3.—Original Papers or Communications, to be followed by discussion thereon.

4.—Announcement of business for the next Meeting.

VII.

A Special Meeting may be called at any time by the Council; and they shall be bound to call such a meeting on receipt of a requisition signed by not less than ten members,

stating the purpose for which the meeting is to be convened. Seven days' notice of a Special Meeting shall be given to every member, such notice to specify the business to be considered; and the meeting shall be held within twenty-one days after the receipt of the requisition. No other business shall be considered at a Special Meeting except that for which it has been called.

VIII.

Field Meetings shall be held at places of geological interest, but none of the private business of the Association shall be transacted on such occasions.

IX.

The votes on any question brought before the Association shall be taken by a show of hands, except those for the election of officers and new members, which shall be taken by ballot.

X.

The manuscript of every Paper read, or a clear and legible copy thereof, written on foolscap, shall become the property of the Association, and shall be placed in the Library for the use of the members.

XI.

In case of non-compliance with the Rules of the Association, or misconduct by any member, such member may be requested by the Council to resign. Failing to do so, the Council may bring the case before a meeting of the Association, which shall deal with it as may seem expedient.

XII.

Every member may introduce a friend at any Ordinary or Field Meeting of the Association, provided, however, that no person qualified to become a member be admitted as a Visitor more than twice in the same year.

XIII.

No addition to, or change in these Rules shall be made except by a majority of not less than two-thirds of the members present at a Special Meeting to be convened for that purpose.

LIVERPOOL GEOLOGICAL ASSOCIATION.

FORM A.

M.....

.....

being desirous of admission to the Association, We, the undersigned, recommend h as a proper person to become a Member.

Dated.....18

Proposed by .....

Seconded by .....

Date Proposed .....

Date Elected .....

Signature of Candidate..... .....

.....Secretary.

REGULATIONS FOR THE ADMISSION OF ORDINARY MEMBERS.

RULE 1.—That every Candidate for Ordinary Membership shall be proposed and seconded by two members of the Association, and balloted for at the next ordinary meeting; and the consent of three-fourths of the members then present shall be necessary for the admission of such candidate.

The Proposal shall be made on Form A. which must be filled up and lodged with the Secretary one week before the meeting at which the Candidate is to be proposed. The proposal form shall be submitted to the Council, and the Secretary shall report to the members any remarks the Council may deem it expedient to make thereon.

RULE 2.—Every Ordinary Member shall pay an annual Subscription of Five Shillings, payable on the 1st October, or, in the case of a new member, within one month after election. Any member not paying the subscription within three calendar months, after being twice informed by the Secretary that it is due, shall no longer be considered a member of the Association.

LIVERPOOL GEOLOGICAL ASSOCIATION.

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LIST OF MEMBERS,

October 3, 1887.

HONORARY MEMBERS.

Dawkins, Prof. W. Boyd, M.A., F.R.S., F.G.S.....Manchester.
Dawson, Sir J. W., LL.D., F.R.S., &c.....Montreal.
Hughes, Prof. T. McKenny, M.A., F.R.S., F.G.S. .....Cambridge.
Judd, Prof. J. W., F.R.S., F.G.S.....London.
Lewis, Prof H. Carvill .....Philadelphia.
Semmons,,W.....London.
Woodward, H, LL.D., F.R.S., F.G.S. .....London.

ORDINARY MEMBERS.

Ashton, F. W..... Spring Lodge, Lyster Road, Fairfield.

Ballard, Rev. F., M,A., F.G.S. ..... Kirkdale.
Banister, H. C..... Rossett Road, Crosby.
Barber, J. M..... 4, Eyes Street, Breckfield Road North.
Beasley, H. C..... Leam Cottage, Wavertree.
Beecham, G. C. ..... 28, Washington Street.
Bellamy, C. R..... Cecil Villa, Grosvenor Road, Liscard.
Brennan, Thomas ..... 127, Granton Road.
Biram, Benj., Assoc. M Inst. C.E... St. Helens, Lancashire.
Bramall, H., M. Inst. C.E. ..... Pendlebury Colliery, Manchester.
Brown, Jos. (Member of Council) ..... 37, Exe Street.

Cade, Lawrence W..... 15, Upper Parliament Street.
Capon, R. M., L.D.S..... 1, Mount Street.
Clague, Daniel (Secretary) ..... 81, Lime Grove, Lodge Lane.
Clarke, F. C..... 87, Alwyn Street.
Conlan, Bernard ..... 22, Mount Pleasant.
Connell, T. R. (Treasurer) ..... Melville Chambers, Lord Street.
Cresswell, F. O. ..... 22, Kings Road, Bootle.

Deane, W. D. H., M.A..... ..... 2, Arundel Avenue.
Dale, J. K. .... 163, Islington.
Davies, S..... 115, Heyworth Street.
Davies, J. Butler..... 71, Boswell Street.
Davies, David .... Lochburn Iron Works, Maryhill, Glasgow.
Defieux, C..... 25, Sandstone Road, Stoneycroft.
Deuchar, P. B..... 17, Kingsley Road.
Dickson, Edmund ..... 30, Eastbourne Road West, Birkdale.
Duff, Samuel .... Endowed Schools, Grey Southern, Carlisle.
Dunsford, A. J. ..... Wynch House, Seacombe, Cheshire.

Evans, E. (Librarian)..... 35, Beresford Road, Toxteth Park.
Evans, J. C. ..... Albany Chambers, Lord Street, Southport.
Elias, O. H..... Mere House, Mere Lane, Everton.

Frazer, John..... 1, Railway Cottages, Spekefield Road.
Findlow, John..... 42, Percy Street.
Finlay, R. F. ..... Slater Court, Castle Street.
Fowler, Thomas Richard ..... Elsdon, Cumberland Road, Liscard.

Gasking, Rev. Samuel, B.A., F.G.S. (Vice-President) ..... 78, Brae Street.
Gray, John A..... 86, Alfred Street.
Gray, G. Watson, A.I.C. ..... 12, Argyle Road, Garston.
George, Isaac E. (Member of Council, Superintendent of Excursions, and Editor) ..... 43, Cairns Street.
Gregson, G. E..... ..... Ribble View, Preston.
Grisewood, W..... ..... Liscard Park, Liscard, Cheshire.
Gowsell, W. H. ... . 20, Bold Street.

Harvie, W. ..... 110, Kirkdale Road.
Hall, Hugh F., F.G.S. ..... Greenheys, Grove Road, Wallasey, Cheshire
Hancox, John ..... 101, Prescot Street.
Hedley, J.L., H.M. Inspector of Mines The Gables, Flooker's Brook, Chester.
Henson, Samuel ..... 277, Strand, London, W.C.
Hewitt, William, B.Sc..... 16, Clarence Road, Devonshire Park, Birkenhead.
Hicks, Rev. Elgar ..... 22, Erskine Street.
Holbrook, The Hon. Henry..... Parkgate, near Chester.
Hornell, J..... 105a, Grove Street.
Hunt, T. S. (Member of Council) ..... 7, Island Road, Garston.

Jackson, R. ..... 6a, Hesketh Street.
Johnson, T. M. ..... 116, Duke Street.
Johnston, W. H..... ..... 6, Lathom Street, Preston.
Jones, R. H..... 17, St. George's Hill.
Jones, R. T..... 105a, Grove Street.
Jones, W. A..... ..... 32, Laurel Road, Edge Lane.

Keyte, T. S., C.E. .... 4, Percy Villas, Napier Road, Willesden Junction, London.
Kissack, J. M..... 18, Newland Street, Everton.

Lewis, A. E..... 74, Rogerson's Quay, Dublin.
Lister, R. F. ..... Streethey, near Lichfield.
Littlewood, T..... Sheffield.

Maguire, T. ..... 108, Landseer Road.
Mannington, C. E..... 16, Geneva Road, Seacombe.
Mannington, H. T..... Pentre, near Flint, North Wales.
Marrow, P. H..... 7, Bell Road, Seacombe.
Martin, W. .....
Miles, Charles E. (Member of Council) 57, Willow Bank Road, Higher Tranmere, Cheshire.
Miles, W. H. (Member of Council) ... 41, Whetstone Lane, Birkenhead.
Mitchell, C. T., F.S.Sc..... College School, Huyton.
Moore, T. J., C.M.Z.S..... ..... The Museum, William Brown Street.
Morgan, James ..... City Engineer's Office, Dale Street.
Morris, John..... 4, The Elms.
Morris, Mrs. John .... 4, The Elms.

Narramore, W..... 5, Geneva Road, Elm Park.
Nicholls, John..... Stockport.

Owen, William ..... 120, Queen's Road.

Padley, F..... 15, Church Street.
Paton, Rev. William..... The Ferns, Parkside, Nottingham.
Potter, Charles..... 101, Miles Street.

Ranford, Miss S..... 25, George's Road, West Derby Road.
Reade, T. Mellard, C.E., F.G.S.,
F.R.I.B.A..... Park Corner, Blundellsands, Lancashire.
Ricketts, Charles, M.D., F.G.S..... 18, Hamilton Square, Birkenhead.
Roberts, Isaac, F.G.S. ..... Kennessee, Maghull.
Roberts, J. Meredydd ..... 91, Cawdor Street.
Roberts, T. D..... 15, Landseer Road.
Robson, Herbert, B.Sc..... Rice Lane, Walton.
Robson, George ..... 1, Sandrock Terrace, Liscard.
Robson, Mrs..... 1, Sandrock Terrace, Liscard.
Rowlands, T. V..... 89, Duke Street.
Rundell, T. W..... Litherland Park.

Schweitzer, W..... 2, Ashfield, Wavertree.
Small, Laurence..... 71, Geraint Street.
Shilston, Thomas, M.I.N.A..... 31, Westmoreland Road, Newcastle-on-Tyne.
Smith, Edward ..... 15, Upper Parliament Street.
Storey, John..... 21, Faulkner Square.

Tapscott, R. L..... 41, Parkfield Road.
Tate, A. Norman, F.I.C. (President)... 9, Hackins Hey.
Tildesley, H. F. ..... 78, Woodville Terrace, Everton.
Thomas, Hopkin..... 4, Cable Street.
Thorp, Josiah ..... 8, Gladstone Road.

Walker, William H..... 40, Castle Street.
Ward, Thomas..... Brookfield House, Northwich, Cheshire.
Webb, Cecil F. (Registrar)..... 46, Wellington Terrace, West Derby Road.
Webb, John R..... 2, Vernon Place, Birkenhead.
Webb, G. H., M.D., L.D.S., Ph.D.. 46, Wellington Terrace, West Derby Road.

Westcott, H..... 94, Princes Road.
Wigzell, Miss M..... 22, Russian Drive, Tue Brook.
Wilding, J. ..... 83, Troughton Street.
Williams, J. J..... 3, Ducie Street.
Williams, Miss L..... 55, Rocky Lane, Newsham Park.
Williams, T. H. ..... 2, Chapel Walks.

Young, Henry..... 12, South Castle Street.

ABSTRACT OF PROCEEDINGS

OF THE

Liverpool Geological Association,

SESSION, 1887-8.

SPECIAL MEETING,

Held in the Free Library, Monday, 3rd October, 1887, Mr. A. Norman Tate, F.I.C., F.C.S., President, in the chair.

Unanimously resolved, on the motion of Mr. T. R. Connell, seconded by Mr. I. E. George, that a new rule be inserted between Rules 2 and 3, to read as follows:—

There shall be a class of Honorary Members, not exceeding ten in number, which shall consist of persons distinguished for their attainments in the study of Geology and its kindred Sciences, or who have rendered valuable service to the Association. Such Honorary Members shall be nominated by the Council, and elected by a majority of votes at an ordinary meeting, and have all the privileges of ordinary members.

Verbal alterations were also made in the other rules, bringing them into harmony with this new rule.

ORDINARY MEETING,

Held in the Free Library, Monday, October 3rd, 1887, Mr. A. Norman Tate, F.I.C., F.C.S., President, in the chair.

MEMBERS ELECTED.—Mr. F. O. Cresswell, Mr. J. Butler Davies, Mr. W. D. H. Deane, M.A., and Mr. R. Jackson.

HONORARY MEMBERS.—The following gentlemen having been nominated by the Council were unanimously elected Honorary Members: Mr. W. Semmons, of London; Professor J. W. Judd, F.G.S., F.R.S., of South Kensington; Professor W. Boyd Dawkins, M.A., F.R.S., F.G.S., of Manchester; Professor T. McKenny Hughes, M.A., F.R.S., F.G.S., of Cambridge; Professor H. Carvill Lewis, of Philadelphia; Dr. H. Woodward, F.R.S., F.G.S., of the British Museum, and Sir J. W. Dawson, LL.D., F.R.S., of Montreal.

The Secretary read the Annual Report, and the Treasurer read the Financial Statement, which were adopted.

The Officers and Council for the year were then elected. (For list see page 2.)

Mr. W. Semmons, one of the newly elected Honorary Members, reported the recent discovery in some Meteorites of a mineral resembling Graphite, but crystallizing in the Cubic system, showing faces and angles of the cube, octahedron and four faced cube.

THE PRESIDENT'S ADDRESS.

(ABSTRACT.)

The President then delivered his address, in the course of which he, after congratulating the members on the work done during the past session, and urging the importance of systematic field work as bringing students of natural sciences face to face with nature, alluded to the International Geological Congress to be held next year in London, and to the valuable suggestions of Sir William Dawson for the federal union of English-speaking geologists, pointing out many advantages to be derived by such congresses and unions. Then referring to a late address by Professor Judd, he spoke of mineralogy considered as a branch of biological science, and of certain points of resemblance and difference between the genesis, development, life and decay of minerals, and similar stages in the life-history of animals and plants, laying emphasis on

the desirability of studying mineralogy more on the lines of biological and physiological inquiry than, as at present, simply as a record of hard, dry facts, surrounded by a nomenclature indicating little of the true history of the matter studied. He further advocated more complete study of the constituents of rocks by means of microscopical and chemical investigation, and urged the desirability of not coming to conclusions on the examination of a few specimens only, inasmuch as the science of Geology was one requiring a very complete groundwork of general scientific knowledge, which should be carefully used in attempting to solve all geological problems.

The preliminary business of the Meeting having occupied considerable time and delayed the delivery of the Address till a late hour, the chief subject of the address, "The Life History of Minerals," will be given in detail at the December meeting.

POSTGLACIAL DENUDATION.

In a paper on the Dry Chalk Valleys and "Coombe rock" of the South Downs, Mr. Clement Reid discusses (Q. J. Geol. Soc., No. 171,) a phase of denudation not hitherto recognised as having operated in Britain. Mr. Reid thinks that the excavation of the steep-sided Coombes of the South Downs was not effected alone by the forces now at work in that area. The "Coombe rock," a mass of unstratified flints, not waterworn, imbedded in a matrix of chalk fragments—all probably derived from the neighbourhood—would seem to require some very energetic agent to account for its production. Torrents of water rushing down the hill-sides would be capable of producing such a deposit, and of excavating deep valleys in the chalk. To account for such a rush of waters over the face of a rock ordinarily very porous, Mr. Reid suggests that during the great cold of the Pleistocene in Britain, the rocks would be permanently frozen to a depth of several hundred feet from the surface, so as to be impervious to water. Under such

circumstances rain would collect on the surface and form rapid streams of great erosive power, quite competent to carry away to lower levels the material loosened by the action of frost. It was pointed out in discussion that in Canada, where the ground is solidly frozen to a certain depth each winter, a greater amount of denudation is effected in 24 hours, at the sudden break-up of the frost in spring, than takes place during the whole of the rest of the year.

The subject is worthy of careful thought in its application to our own neighbourhood. Probably we have no unstratified deposits hereabouts of other than glacial origin, but the means by which the dry gulleys of Thurstaston, Heswall, and Broxton were excavated is not by any means clear in the absence of some such explanation as that advanced by Mr. Clement Reid. I. E. G.

EXCHANGES RECEIVED.—Transactions of Manchester Geological Society, parts 8, 9, 10; Proceedings of Geologists' Association of London, May, 1887.

ORDINARY MEETING,

Held in the Free Library, Monday, 7th November, 1887, Mr. A. Norman Tate, F.I.C., F.G.S., President, in the Chair.

COMMUNICATIONS.—Letters were read from Prof. J. W. Judd; Prof. T. McKenny Hughes; Mr. W. Semmons; Prof. W. Boyd Dawkins; Prof. H. Carvill Lewis; and Dr. Woodward, accepting their election, and promising their co-operation with us in our work.

NOMINATIONS.—Mr. John Dakin, 15, Highfield Crescent, Rock Ferry; and Rev. H. C. Leworthy, of 197, Conway Street, Birkenhead.

The Secretary reported that the Council had made the following appointments:—

Superintendent of Excursions and Editor..Mr. I. E. GEORGE.
Librarian .. .. ,, E. EVANS.
Registrar .. .. ,, C. F. WEBB.

and the following departmental referees:—Paleontology, Rev. S. Gasking; Chemical Geology, A. N. Tate; Mineralogy, D. Clague; Microscopy, I. E. George.

EXHIBITS.—Mr. C. Potter exhibited several specimens of Coal and Galena, which had been uncovered at Meols by the late storm, which he supposed were the relics of a forge of very ancient date which had existed there, worked probably by the men whose implements have been found occasionally in that district. He also exhibited an interesting tool—probably a chisel, in Obsidian, from the Transvaal.

A Paper was then read by the Rev. S. Gasking, B.A., F.G.S., entitled

"WITH THE BRITISH ASSOCIATION IN THE ISLE OF MAN."

"The proper study of mankind is man."—Man topographically. So thought the members of the British Association, for they readily accepted the courteous invitation of the Isle of Man Natural History and Antiquarian Society, to come and

spend a few days in that highly favoured spot. Having been specially requested by the worthy Secretary of the Society to come over and help in the big show, I, as a son of Man, was truly anxious to render what little service I could; so replied at once that I should cross from Liverpool. In going over, a strong gale was blowing, which served nicely to instruct the non-geological members of the British Association as regards the power of the sea as an agent of destruction. As we felt the great thuds against the sides of the steamer, and witnessed the cannonading of the huge rocks near Douglas Head by Neptune's artillery, the tyro in geological knowledge was able to understand something about marine denudation.

The official programme for the Saturday's excursion showed that the principal points of interest to the Geologist were as follows:—1st, The examination of the Lower Carboniferous shingle beaches resting on the Lower Silurian rocks at Derbyhaven and Langness. 2nd. The Carboniferous Volcano of Scarlett Point, with the associated ashes and tuffs, and the old Lava Dykes which traverse the district. 3rd. The Carboniferous Limestones and Shales. The first stop was accordingly made at

LANGNESS,

where the party examined the natural arches, the Shingle Beaches and the underlying rocks. Here what has been termed the basement conglomerate was splendidly exposed in the cliff on the eroded and tilted edges of the slate. A short distance away it was seen to be thrown down by a fault. Being traced along the shore, it was observed to dip beneath the limestone, plainly showing that it was formed anteriorly to that formation, and therefore must be considered as probably of Ordovician age. Cumming regarded this conglomerate and the beds of sand with which it is associated as Old Red, and so it is named by him in his book on the Isle of Man, yet, at the same time, if you read what he says, you will find that he admits the perfect conformity of these underlying

formations with the limestone above. A certain Mr. Howarth, on a three days' trip to the island, stated that these beds represented boulder deposits of the Glacial period. Mr. G. H. Morton, ex-president of the Liverpool Geological Society, took another three days' trip to the same place, and replied to Mr. Howarth in the "Geological Magazine," asserting that Cumming was right. Mr. P. H. Marrow, member of our Association, on another three days' trip, wandered to the same spot, and his testimony, I believe, agrees with what Mr. Morton says. Our Secretary, Mr. D. Clague, has visited the place many a time, and in his paper on the "Geology of the Isle of Man" ventured to state (he will correct me if I am in error) that Cumming was right in part and Mr. Howarth right in part. Whilst admitting that with respect to certain formations in this neighbourhood Messrs. Cumming, Morton, and Marrow are correct in their statements, yet he is ready to agree with Mr. Howarth with regard to other deposits being of a truly glacial character, and referable to the Boulder Clay period. Although I have traversed this district often, I really cannot say that I have discovered such deposits, and therefore I am afraid he must have been mistaken. At a point low down on the beach, standing upon the Conglomerate dipping seawards beneath the Limestone which lay upon it quite conformably, I mentioned Mr. Howarth's statement to Professor Boyd Dawkins, and he, therefore, said to those gathered round him:—"I believe it has been stated in some quarters that this Conglomerate belongs to a period long after the deposit of the Limestone. But here you have proof, on account of it plunging below the bed, that it belongs to a period before the Limestone. The Limestone is formed in tolerably clear water, while the Conglomerate is, of course, on the shore line. And the fact of finding the Limestone above the Conglomerate shows that at the time the land was sinking, the pebble beaches were gradually being depressed into clear water." The Rev. J. Clifton Ward says:—"Nothing could be clearer than that the Conglomerate beds underlie the Carboniferous

Limestone, that they are almost wholly made up of sandstone or quartzite pebbles, and that the beds do not represent boulder deposits of the Glacial period." This Conglomerate, then, must not be regarded as of Old Red Sandstone age, rather I agree with Mr. Horne, that "there is presumptive proof that it is really of Lower Carboniferous age," and with him I would be disposed to consider "that the beds may be correlated with the Calciferous Sandstone series of Scotland," which, according to Woodward, "are homotaxial with the Tweedian group and the Lower Limestone Shale." The cliffs north of Peel are composed of Red Sandstone, portions of which partake of the nature of Conglomerate. They run in a northwesterly direction, and were overlaid at one time by the Limestone, which even now exists some little distance beneath the water. These beds are of the same age as those of Castletown, and have received careful attention from Mr. Horne, who thinks that they are to be referred to the Lower Carboniferous period. At Scarlett Limestone Quarry a pause was made in order to notice

THE ACTION OF ICE.

The soil had only recently been removed from an upper portion, so that the polishing and scratching which betokens the work of a Glacier were to be plainly seen. Several holes were also observed, probably caused by the action of carbonic acid and rain water. These agents readily attacking weak parts, and so producing the characteristic surface there presented to the view. The Stack was the next object of attention, but could not be reached on account of the tide. However the Trap rocks in the neighbourhood had great attractions for many. First, the Limestone was noted in close proximity to the trap; Cyathophyllums and Madrepore in one spot seemed to abound, then a fault was observed near at hand, filled with Breccia, which cut off this coralliferous Limestone. In examining the tufa hereabouts I was accompanied by Professor Carvill Lewis, of Philadelphia, when, suddenly I came upon

a detached piece of rock, which to me seemed uncommon, and I drew the Professor's attention to it. Upon looking at it very carefully, he declared it to be "Hornblende Andesite," which had not previously been recorded as from these parts. Immediately we came across the rock in situ. Several portions of the great lava-flow which covers the surface in this neighbourhood were examined and were found to exhibit a vesicular structure. The basaltic column, which is known as "the Stack," was, at one time, no doubt,

AN ACTIVE VOLCANO

beneath the water, which, belching forth its molten materials, quickly erected its cone above the level of the surrounding sea. Before the cone appeared, the ejected matter would have spread over the sea bottom, then when it did rise to the surface, the ashes would be thrown up into the air to fall gently and form the condition of things there seen to exist. The Volcanic material thins away from the great central point of disturbance in west north west direction. Soon the abundant greenish ash becomes not so coarse in its constituent parts, then shortly you come across volcanic ash interbedded with Limestone, the latter having a rather altered character, being black in colour and of the hardness of flint, through its connection with the heated matter from the Stack. On the shore, in front of the excavations made in the Posidonomyarian Schist, a very large trap dyke runs through the Limestome. This dyke is much more recent than the volcanic matter just mentioned. The Carboniferous Limestone had long been deposited, and the volcano at the Stack had long been dormant, when other disturbances took place, causing this huge dyke to push its way through the mass of Limestone. Near the shore it bends round so as almost to form a semi-circle. It consists of "Dolerite," or, as Professor Carvill Lewis stated, "Picrite."

On Monday an excursion to Peel and Foxdale was arranged. The programme was a tempting one for the Geologist. Foxdale Mine, with its great lode of argentiferous galena travers-

ing the granite and the schists, the curious association of minerals, the large blocks of granite embedded in the vein stuff, the carbonic acid gas issuing from the deep workings, and the alteration of the granite in the neighbourhood of the lode, was certainly well worthy of a visit. A stop was first made at Crosby in order to inspect a quarry a little south of the station, in the side of the hill. In those far off times when lovely Mona was troubled with volcanoes, a stream of rock-matter in a molten state ran through the clay slate in this neighbourhood. Having cooled down it now forms a great dyke which may be traced running through the elevations on the other side of the valley. This dyke is formed of a material that Professor Lewis stated was "first cousin to granite." I had been there frequently, but this was, I believe, Professor Dawkins' first visit. The point to be noticed, as he well said, is "the curious alteration caused in the dyke and on the slaty material in its immediate neighbourhood. On that side you will see the slaty structure pretty nearly obliterated, and a quantity of dark crystalline material going to it, which is a first cousin to hornblende. These crystalline rocks are traversed by a line of cleavage, or something of that sort. They are roughly parallel to the slaty rocks on either side. Above, you see the slaty rocks in immediate neighbourhood with the lower purely crystalline rocks, and planes of deposition are roughly parallel to the inclination of the side of the fissure." Another stop was made at Poortown, or Ballakilmurrey, and the quarry there explored. Here we came across a dull cindery kind of material varying from dark green to dark blue. This rock was pronounced by Professor Lewis to be

GABBRO,

an eruptive rock by no means common in England, because so quickly changed to other different sorts of rock; for when Gabbro is subjected to pressure, it becomes hornblende rock. Possessing no free silica, it consists of diallage, a little olivine, and a basic felspar, probably labradorite, and may also con-

tain titanate of iron. After leaving Peel, with its Red Sandstone of which I have spoken, we next halted at the

FOXDALE MINES.

Here, by the kindness of Captain Kitto, we were conducted to certain spots of great interest. At one excavation to which we were led, the chief characteristic was the contrast between the true and altered granite. Then we passed to a larger quarry, where the granite and slate were side by side. Reference was made to the absence of change in the comparatively soft slate when brought into direct contact with the granite. Although this was apparently the case here, yet there is after all some slight alteration. If the under side of the slate be examined, it will be seen to be metamorphosed. Mr. P. H. Marrow has some very good specimens from this locality, plainly exhibiting metamorphism beneath. In a streamlet hard by was some granite of very fine texture, known as Elvanite. The great lead vein of Foxdale cuts clean through granite and the slate. Close to the lead vein, the granite is in places of a green colour. Here, then, we have "Smaragdite," caused by the action of water, containing acid in solution upon the felspar, in its passage through the mineral vein and the contiguous granite. The principal vein runs east and west, and is crossed by several others taking a north and south course. On Tuesday the excursion was to Laxey, chiefly to see the mine.

LAXEY MINE

is 271 fathoms deep, and instead of cutting through the granite as Foxdale Mine does, this cuts entirely through the slate. The lode varies greatly, ranging from half-an-inch to 18 feet in thickness. Captain Reddicliffe, who kindly led us over the works, stated that the lead was pretty rich in silver, as it contained about 400 ounces to the ton. The mine yields also a large amount of zinc blende; copper only occurs in small quantities. The Laxey shore was then visited to examine some large markings on the rocks, commonly put down as the

footprints of some extinct animals. Professor Lewis, to whom I showed these markings, said that "they are hollows due to the rotting out of concretions or knots; these knots are formed in the original clay by the segregation of parts of it; they have been lengthened out subsequently by the same force which changed the mud into slate; they are not organic, but purely ordinary natural formations, and can be seen in many parts of the world." Professor Panton, of Guelph, Canada, also agreed with Professor Lewis; so, too, did Professor Dawkins upon his arrival at the spot. Upon my taking the party still further south, where there were markings very like a human foot, I remarked that similar ones existed at Dalby and at Port Soderick; it was apparent to all that they occurred in pairs; this was the singularity. After a deal of speculation, Professor Dawkins said that they were very pretty, but he could not account for them. The latter also pointed out what he termed "ripple marks" on the face of the sloping rocks. Professor Lewis, however, was of opinion that the wavy outlines were caused by pressure. The rocks at Port Soderick are exactly similar, and present the same crumpled appearance, and as the clay slate in both localities has been more indurated than metamorphosed, it is most likely that Professor Dawkins is right. I will conclude with a remark made by Professor Lewis on the way home from Monday's excursion; he said, "wherever I have been, I never in my life saw any area in the world where the whole genesis of geological formation is so distinctly visible as here in the Isle of Man."

EXCHANGES RECEIVED.—Report of the Smithsonian Institution, 1885, part 1; Fifth Annual Report of Library, Barrow-in-Furness; Journal of Liverpool Astronomical Society, November, 1887; Transactions of Edinburgh Geological Society, vol. v, part 3; Catalogue of Edinburgh Geological Society's Library.

ORDINARY MEETING,

Held in the Free Library, Monday, December 5, 1887, Rev. S. Gasking, B.A., F.G.S., Vice-President, in the Chair.

ELECTIONS.—Mr. John Dakin and Rev. H. C. B. Leworthy.

NOMINATIONS.—Mr. Richard Williams, 88, Granby Street; Mr. D. Jones, 73, St. Alban's; Miss Caughey, 31, Balmoral Road; Mrs. S. Scott, 56, Irlam Road, Bootle.

EXHIBITS.—Sopwith's Geological Models were exhibited by Mr. C. F. Webb; and Glass Models illustrating the Six Systems of Crystallography were exhibited by the Secretary.

In consequence of a message having been received from the President regretting his inability to attend to read his paper on "Minerals, their Genesis, Growth, and Decay," the Secretary, Mr. D. Clague, gave a short address on Mineralogy, urging the members to give their attention to the subject as one deeply interesting in itself and a knowledge of which is essential in a geologist.

Mr. Knott then exhibited a series of sections of minerals with the lime-light lantern, which were explained and discussed by Messrs. I. E. George, D. Clague, H. T. Mannington, C. E. Miles, and the Chairman.

ASSOCIATED SOIREE.

This annual festival of the Scientific Societies of Liverpool and neighbourhood was duly held in St. George's Hall, on Wednesday, December 21, when the various societies exhibited illustrations of the work in which they were engaged.

The Liverpool Geological Association took its place amongst the exhibitors, and made it clear that the members of our Association were engaged in good, useful work. The exhibit was under the care of the referees recently appointed, and showed that the new departure towards departmental work was a judicious one.

In the Microscopical department a series of sections of igneous rocks, illustrating their crystalline differences, was

under the supervision of Mr. George, members and friends assisting him by the loan of their microscopes.

In the Mineralogical department a choice collection of Iron and Manganese Ores was contributed by the President, A. Norman Tate, Esq., F.I.C., F.C.S., and a collection of small boxes, each containing a few selected and named minerals, which are intended to be circulated amongst such of our members as care to study them; so commencing our work in this section.

The educational value of such a movement was gladly recognised by the officers of scientific societies from neighbouring cities, who expressed their intention of copying the example thus set before them.

The Rev. S. Gasking, B.A., F.G.S., took charge of the Palæontological department, and himself contributed a good collection of fossils from the coal measures, supplemented by fossils from the Carboniferous Limestone and the Yoredale Rocks, and also by a series of fossils from the Lias formation.

Mr. C. F. Webb's exhibit of Sopwith's Geological Models, illustrating faults, outcrops, &c., although not belonging to either of the above departments, was an interesting exhibit and attracted much attention.

To the above report of our Secretary should be added a word as to some valuable cases contributed to the exhibit of the Liverpool Geological Society. The mammalian remains recently disinterred from the Ffynnon Beuno Cave in North Wales were well represented in a case exhibited by Mr. G. H. Morton, who is one of the gentlemen appointed by the British Association as a committee for the exploration of the cave. Mr. J. Fitzpatrick's illustrations of the forms of Carbonate of Lime were representative of a very wide range of structure and origin. I. E. G.

MUSEUM VISITS.

This important feature of our work commenced for the season on Saturday, November 19th, when Mr. I. E. George

gave a demonstration on the "Life of the Pliocene Period," as illustrated by fossils from the Crag formation of East Anglia. The splendid representative collection in the cases made the lecturer's task an easy one. Beginning with the Coralline Crag, at the base of the series, the fossils were considered as illustrating the conditions under which the beds containing them were laid down. Thus, comparatively clear and still water, favourable to the growth and accumulation of polyzoa, sometimes became the scene of rapid tidal currents where shells were much comminuted; whilst at other times estuarine gave place to fresh water conditions. Higher up in the series there were also evidences of a gradual lowering of temperature indicated by the increasing number of Arctic shells and diminution in the number of species of southern forms.

On Saturday, December 17th, a second visit was paid to the Museum, William Brown Street, when Mr. T. J. Moore, F.Z.S., the Curator, gave an address on Kent's Cavern and the geological work done there by Mr. Pengelly, F.G.S. The address was copiously illustrated by the collection of mammalian bones which have been added to the Museum from the classical district referred to.

THE CONGLOMERATE BEDS OF THE ISLE OF MAN.

In his report of the visit of the British Association to the Isle of Man, the Rev. S. Gasking, B.A., F.G.S. (Journal, page 23), represents me as saying that some of the conglomerates of Longness are of the Glacial Age. I do not know Mr. Gasking's authority for such a statement; certainly it is erroneous, as I think the following extract will show.

In the abstract of my paper on the "Geology of the Isle of Man," read September 1, 1884 (Transactions, vol. 4, page 81), I say "that a close study of them tends to show that the conglomerates in the south of the island belong to different ages, and were laid down under different circumstances, and that much work needs to be done in this department," but no reference is made to any of them belonging to the GLACIAL AGE.

On referring to the manuscript, of which the printed report is but a short summary, I find that I referred to the same mass of conglomerate which was shown by Professor Boyd Dawkins, and pointed out, as he did, that it dipped below the Limestone, and therefore is older than that bed. I also mentioned that at Cosnahawen, a little to the north-east of Longness, I found pebbles of limestone in the conglomerate, and had been shown by fellow students pebbles of limestone containing carboniferous fossils in lumps of conglomerate from the same place, proving conclusively that some of the conglomerates are of a more recent age than that to which Professor Dawkins' attention was directed.

To these statements I still adhere—and, furthermore, having studied the conglomerates near Silverburn, to the north of Balla Salla, and at other places in the *south of the island*, I think it quite possible that when thoroughly studied they may prove to be still more diverse in their age and character than I have shown two of the beds to be, but I must decline to be responsible for the statement that any of them belong to *the Glacial Age*.

D. CLAGUE.

EXCHANGES RECEIVED.—Transactions of the Geological Society of Australasia; Transactions of the Manchester Geological Society, vol. 19, Nos. 11—12.

ORDINARY MEETING,

Held in the Free Library, Monday, January 9, 1888, Mr. A. Norman Tate, F.I.C., F.C.S., President, in the Chair.

ELECTIONS.—Mrs. S. Scott, Miss Caughey, Mr. D. Jones, and Mr. R. Williams were elected to membership.

NOMINATION.—Miss Ellen Taylor, 58, Irlam Road, Bootle.

DONATION.—"Cosmos," by Humboldt, in 2 volumes, was presented by Rev. S. Gasking, B.A., F.G.S.

A paper, of which the following is an abstract, was then read by the Rev. F. Ballard, M.A., F.G.S., on

CAVE DEPOSITS CONSIDERED IN RELATION TO ESTIMATES OF TIME.

Whilst it might be truly said that geological science as a whole was yet in its childhood, the discovery and investigation of caves and their deposits was a branch of the parent tree which had only of late years begun to bear trustworthy fruit. So soon as the early scepticism of former geologists was overcome in regard to the evidences of great antiquity borne by the cave deposits, and especially in regard to the presence of man, the tide began to set in strongly in the other direction, and a tendency developed itself to put the most extreme and fabulous estimates upon the periods required for cave deposits. This tendency had by no means exhausted itself, for in a work lately published in Paris by M. de Mortillet, the Professor of Prehistoric Anthropology in that city, the author deduced from his data the marvellous conclusion that man appeared upon the earth 230,000 years ago; and our own Mr. Pengelly, lecturing at Manchester, had taken the inscription from Kent's Hole as warranting the conclusion that a stalagmite formed there since man had first inhabited the cavern required a period of 300,000 years, being at the rate of 1 inch in 5,000 years.

The lecturer then proceeded to discuss the various classes of evidence upon which time estimates had been formed. The position of the entrance of the cave with regard to altitude above the floor of the adjacent valley or sea-level was something which we could consider. It was highly probable that

the present entrances would have been made by the enormous river torrents and floods of the Quaternary period, which it was presumed had violently scooped out existing valleys, exposing first one cave and then another as they cut down to lower levels. Hence those caves which stood high above the present floor of a valley would be older than those lower down the slopes, and all fluviatile deposits found in them would date from the period of their exposure. It was evident that in the case of some of the caves their contents had been frequently washed out by floods, so that the age of subsequent deposits would necessarily be less than if we viewed the postpliocence denudation from a uniformitarian point of view. There was, then, always the element of uncertainty with regard to the age of cave deposits, as to whether they represented the earliest there formed, or whether they succeeded a series of beds which after deposition had been washed out by floods. Nor was it any easier to deduce estimates of time from the thickness of these deposits, or even to get a reliable measurement as to the rate of growth of any of them. To get this in the case of stalagmite we should require to know at least the quantity and quality of acidulated water concerned in the work. Mr. Pengelly's calculation for a portion of the stalagmite in Kent's Cavern was based upon an assumed growth of 1-20th of an inch in two centuries and a-half, so that, at this rate, a truly vast antiquity would be assigned to those human remains which were covered by 12 feet of stalagmite. But Professor Boyd Dawkins supplied us with some measurements from the Ingleboro Cave, by which we learnt that a certain mass of stalagmite there was found to be growing at the rate of nearly one-third of an inch per annum, so that 8 inches would be formed in 28 years at Ingleboro, and in 40,000 years at Kent's Cavern. Speaking of the great variation in the rate of growth at different places, Professor Boyd Dawkins observed:—"It is obvious, therefore, that all speculation as to the deposits in caves which is based on the view that the accumulation is very slow is without value."

Another argument as to the great antiquity of cave deposits had been based upon the assumption that as the extinct mammalia with which man was contemporary extended back to Preglacial and even Pliocene times, any deposits containing such remains must on that account be assumed to possess great antiquity. But it seemed to the author that the question which they had to ask themselves was not how far back did these extinct mammalia extend, but when did they die out? He thought there was no reason why instead of pushing back the caves with their contents to the supposed flourishing time of the hyæna, cave lion, and woolly rhinoceros, we should not bring forward those mammals to any time which upon other grounds the caves and their contents might seem to have represented. Those creatures might have lived in any period from the Pleistocene to the Eocene, but if they lived on also to recent times it is manifest that their bones may be found in river gravels and cave deposits, alongside of human implements, without in the least proving the extreme antiquity of the latter. Professor Prestwich, who might be regarded as unbiassed in his testimony, said: "I do not for my part see any geological reason why the extinct mammalia should not have lived down to comparatively recent times." And again, in the Proceedings of the Royal Institution (1864), he says: "I am confirmed in the opinion expressed in 1859 that the evidence as it stands seems to me as much to necessitate the bringing forward of the great extinct animals towards our own time as the carrying back of man near geological time."

The works of Dawkins and Lyell contained numerous instances of the remains of extinct and existing mammalian forms being found side by side. Thus, at Kent's Cavern (Report of Exploration for 1874), it was mentioned that in the Long Arcade, in undisturbed cave earth, there were found remains of rhinoceros, hyæna, mammoth, and machairodus, along with those of horse, fox, and pig. As no one contended for the extreme antiquity of the latter, to what other conclusion could we come than that the former had become

extinct very recently. Professor Dawkins' opinion on this subject was well worth quoting when he said: "It is easy to refer a given cave to the age of the reindeer or mammoth because it contains the remains of these animals, but the estimate has been rendered worthless for chronological purposes by the fact that both these animals inhabited the region north of the Alps and Pyrenees at the same time, and are to be found together in nearly every bone cave explored in that area."

In conclusion, the author submitted that the difficulties of the case gave rise to such uncertainty that it would be highly unscientific to insist either upon enormous or upon exact periods of time in relation to the age of the cave deposits with which we are acquainted.

In the discussion that followed the reading of the paper, Mr. Gasking said that after a fairly close study and pretty extensive examination of caves, he quite agreed with Mr. Ballard that it would be impossible to come to any conclusion as regarded the age of cave deposits and their contents from a consideration of stalagmitic growth alone, as this exhibited such great variation under different circumstances.

Mr. George thonght that Mr. Ballard's strictures as to disturbance of cave deposits by floods were of too general a nature to be of value in reducing the supposed great antiquity of the deposits in such a receptacle as Kent's Cavern, or in showing that there had been any violent break in continuity there. Had such floods ever rushed along the passages of any bone cave, they would certainly have left behind them sufficient traces of their action in the way of eroding channels through stalagmites, wearing out pot-holes, and depositing gravel and sand on the floor, to attest the fact. In a visit he had paid to Kent's Hole he had not seen any such evidences, nor did he remember having seen them noted in any of Mr. Pengelly's reports; whilst the fine clay found in limestone caves seemed to represent the insoluble residue of the limestone, and need not have been brought from without at all.

EXCHANGES RECEIVED.—Journal of Liverpool Astronomical Society, vol. 6, parts 2-3; Transactions of Burnley Literary and Scientific Club, vol. 4.

ORDINARY MEETING,

Held in the Free Library, Monday, February 6, 1888, Mr. A. Norman Tate, F.I.C., F.C.S., President, in the Chair.

ELECTION.—Miss E. Taylor.

NOMINATIONS.—Miss M. A. Smith, Miss B. C. Staley, and Miss E. F. Staley, all of Seafield, New Brighton; and Mr. J. W. Lunt, 70, Strand Road, Bootle.

EXCHANGES, &c., RECEIVED.—The Lepidopterous Fauna of Lancashire and Cheshire, part 6, by Dr. J. W. Ellis, presented by the Author; Abstract of the Proceedings of the Geological Society of London, parts 510 to 514, presented by Mr. G. H. Morton, F.G.S.; Journal of Liverpool Astronomical Society, vol. 6, part 4; Transactions of the Manchester Geological Society, vol. 19, part 13; Report of the Goldfields of Victoria, presented by the Department of Mines, &c., Melbourne.

EXHIBITS.—The Referee in Microscopical Geology had on the table for use of the members, a microscope and several slides of rock sections, being part of a set of slides to be lent to the members for home study. The Referee in Mineralogy had also several pocket cases of minerals, which were lent to such members as wished to study them during the month.

COMMUNICATIONS.—The Secretary drew attention to an article by Sir J. W. Dawson, LL.D., in the current number of the Geological Magazine, which contains some new facts relative to the Eozoon Canadense.

A Paper was then read by Mr. Charles Potter, entitled

ON SOME FACTS IN CONNECTION WITH THE GEOLOGY OF THE MERSEY BASIN.

The question which I would specially treat may be stated thus:—Has that portion of the River Mersey below Runcorn ever flowed in any other channel than that it now occupies, since the post-glacial deposits—known as the upper and lower forest peats and the upper and lower Scrobicularia beds—were formed? Those who contend that it has not must take up a negative position, but those who contend that it has should be able to assume the positive, and show the course in which it did flow, more especially as they mostly

affirm that the present outlet of the Mersey did not exist in earlier periods, if it existed at all, during the Roman occupation of this country.

Since the land of this country attained its present level, the water sheds and their natural drainage must have been, with but slightly varying alteration, the same as we find them to-day. So far as we are now concerned, the smaller tributaries of the Lower Mersey may be lost sight of, and the three larger, the Weaver, the Upper Mersey, and the Irwell, alone need be treated of. The water brought down by these rivers, especially in the time of winter floods, is so large that it must inevitably have cut a channel through the post-glacial and glacial deposits to the level of the lowest Spring tides. Under no possibility could such a channel have been formed across the Cheshire peninsula south of the foot of Bidston Hill; and any outlet by the Cheshire shore for such a river would be confined to the space between the rocks known as the "Red Noses," on the New Brighton shore, and the "Red Rocks," on the Hoylake shore. The narrowest part of the marsh land available for this imaginary channel is that by the Leasowe Lighthouse, and lying between the littoral and the "Birket," a stream sweeping round the foot of the higher land of Moreton, which here sinks into the marsh. As this space in its smallest width will not exceed two hundred yards, it should be comparatively easy for such a channel to be pointed out, did it ever exist, more especially as after two hours' ebb of the tide there will seldom be any difficulty experienced in passing along the whole length of the shore between the New Brighton rocks and those at Hoylake, on the littoral below the sand-covered portion. Along the whole of this distance the pedestrian will be walking on the Boulder Clay, or the well-defined superimposed beds. If, as some assert, the land stood at a higher level when the Mersey was supposed to have flowed in this Cheshire channel, the depth of the river bed must have been greater in proportion to whatever height the land stood at above the present level, and this old channel

would be an object which the most superficial observer could not pass over without his attention being drawn to it.

As bearing on this subject, I would refer my hearers to a paper (in the Transactions of the Lancashire and Cheshire Historical Society, 1878-9) by Mr. T. Glazebrook Rylands, on "Ptolemy's Survey of England," in which it is shown that the Mersey channel as now known to us was laid down by Ptolemy with mathematical accuracy; whilst that greatest of our local Geologists, the late Mr. Robert Bostock, read before the Geological Society of Liverpool, in 1870, an exhaustive paper conclusively proving to any unprejudiced mind the impossibility, since the land attained its present level, of the Mersey having flowed to the sea in any other than its present channel.

In conclusion, allow me to hope that in our Association we may have many wishful to tread in the footsteps of Mr. Bostock. He was a close and correct observer, never putting up himself or his imagination in opposition to facts, and who, as an authority on the strata from the triassic rocks to the coal measures of this neighbourhood, will be very long missed by the Geological student.

NOTES ON THE ANNOUNCEMENT OF THE DISCOVERY OF A VOLCANIC GLASS OF PALÆOZOIC AGE.

There has just fallen into my hands a copy of the "Scottish Naturalist" (the organ of the East of Scotland United Naturalists' Union) for October last, and it has occurred to me that a brief extract from a contribution by Mr. James Dorham, F.G.S., on "Volcanic Glass" would be of interest to our members.

"The capability of cooling into a glass seems to depend to a very great extent upon the quality of the lava. Extremely acid lavas most readily form the most perfect glasses, often of great extent and thickness; while basalts become glasses, for the most part, only along narrow lines of contact with other

rocks, which rapidly deprived them of their heat by radiation and absorption.

Students of volcanic rocks of Palæozoic age have always been impressed with the apparently entire absence of glasses among the ejecta of these ancient volcanoes, even when the stony lava-streams seemed identical with those of recent eruptions. This absence of glass, along with certain differences of mineralogical structure, induced one school of geologists to come to the conclusion that volcanic eruptions in Palæozoic times were entirely different in character from those of Tertiary and recent ages. On the other hand, geologists continue to maintain that all through the ages volcanoes have behaved just as they do to-day, and explain the absence of glasses and the other mineralogical differences as being the result of changes arising in the rocks through chemical and physical actions, prolonged throughout the ages during which these rocks have been buried in the ground.

This rock strikingly confirms the conclusions of the uniformitarian school of geologists (mainly British), as in it we have a perfect glass of Palæozoic age, readily recognisable as such by any one who cares to examine it. It occurs in this wise. A breccia, that is a confused mass of angular fragments of volcanic rocks, which probably formed part of the crater-cone of a volcano of the Old Red Sandstone age, near Tay Bridge, Newport, Fife, is mostly composed of masses of all sizes of quartz-andesite, one of the more acid members of this intermediate group of volcanic rocks. In many of the large blocks of the quartz-andesite (or, as petrologists call it, Dacite) are hollows of considerable capacity relatively to the size of the block. It is in one of these hollows, in a huge block on the plain of the beach, that the glass occurs. It mainly fills the hollow, but is surrounded with a considerable quantity of a white powder, which is the glass in its last stage of decay."

W. D. H. DEANE.

ORDINARY MEETING,

Held in the Free Library, Monday, March 5th, 1888.

ELECTIONS.—Miss Smith, Miss E. F. Staley, Miss B. C. Staley, and Mr. J. W. Lunt.

NOMINATION.—Miss K. Meek, 21, Church Street.

EXHIBITS.—Alpine photographs, and minerals from Vesuvius, exhibited by Miss Williams; views of Swiss scenery, by Mr. T. S. Hunt.

DONATIONS.—"Our Gold Supply," by T. Cornish, M.E.; "The Metallic Ores of Cornwall," by W. Semmons, M.M.S.; "Local Historical Pre-glacial and Post-glacial Geology," by G. H. Morton, F.G.S. *Presented by the Authors.*

EXCHANGES.—Transactions of the Manchester Geological Society, vol. 19, Nos. 14 and 15; Annual Report of Liverpool Engineering Society, 1887; Transactions of Liverpool Engineering Society, vol. 7; Transactions of Nottingham Naturalists' Society, 1887; Nineteenth Annual Report of Liverpool Microscopical Society, January, 1888; Annual Report of the Liverpool Polytechnic Society, 1887.

An Address was delivered by the President, on
THE BIRTH, GROWTH AND DECAY OF MINERALS.

MUSEUM VISITS.

During the past winter several pleasant and instructive meetings have been held at the Free Public Museum, William Brown St., when the work done was mainly Palæontological.

Mr. Gasking, in his Lecture on the "Life of the Cretaceous Period," gave a graphic description of the scenery of the Chalk Districts of England and France, and then proceeded to discuss the conditions under which the Cretaceous Rocks were accumulated, illustrating his remarks by reference to the cases of fossils before him. Mr. George's Demonstrations gave a similar treatment to the Eocene and Crag Periods of England.

Mr. Higgins's Lecture on the "Univalves" was given in

his usual chatty style, and proved full of interest to his listeners. The Gasteropoda being such an extensive group, attention was devoted on this occasion to the land and fresh water shells. Some account of their structural peculiarities was given, and the facts concerning their distribution in time and space were so related as to add greatly to the interest with which the Gasteropoda are always regarded.

A case of Tanganyika shells recently added to the Museum was described as specially noteworthy. Instead of belonging to well-known genera of fresh water shells, the Univalves of Tanganyika had their nearest allies in marine forms. This fact appeared to indicate that salt-water conditions had formerly prevailed over Central Africa, and that the freshening of isolated areas had been effected so gradually that the old marine forms had been enabled to survive the change of conditions.

FIELD MEETING.

On Easter Monday, April 2nd, the Members of our Association, along with other students of geology, visited St. Helens, walked by Ravenhead to Thatto Heath, and thence to Sutton Heath, studying various features connected with the Coal Measures.

In addition to the features noticed on a previous occasion, (Sept. 10, see Transactions Vol. VII, p. 102) the mineral deposits attracted considerable attention. Deposits of Hydrous Iron Oxide, both crystalline and amorphous, and specimens of Iron Carbonate and Iron Sulphide were obtained, whilst Clay Iron Stone was exceedingly abundant. Dolomite Crystals were also found somewhat plentifully.

In addition to these there was found a mineral of lead-grey colour, with brilliant metallic lustre, having a hardness of 6·5, streak dull grey, giving reactions for iron, lead and antimony, which does not appear to be mentioned by any of the authorities.

SOME NOTES OF A HOLIDAY IN THE ISLE OF MAN.

So many of our Members are likely to visit the Isle of Man this summer that a few notes on some points little dwelt upon in previous papers on the geology of the island may give additional interest to a holiday which includes a walk round the southern shore-line.

Following the coast along the eastern border of Langness, notice the numerous deep indentations in the land. These are only to a slight extent, some not at all, occupied by the sea at present. Their floors may be grass-grown and quite beyond the reach of marine denudation, and they seem to have been carved out by the sea in the direction of massive joint-planes at a period when the land stood at a slightly lower level. At the south-western spur of Langness, the sea now occupies the floor of several of these widened joints at high tide, and cuts up the promontory into a number of little islets. Two or three small dikes of greenstone cut across these stacks, and may be visited at half tide. The intensely indurated reddish quartzite blocks in the conglomerate to west of the lighthouse, is worthy of examination. A very large erratic of conglomerate resting on the shore by the copper mine should be examined; it is foreign to Langness, but may be found to correspond with some older conglomerate on the island; that of Santon should be compared with it.

In Scarlett limestone quarry there will be noticed, where the boulder clay and soil have been removed from the surface rock, evidence of two kinds of denudation. The polished floor of the old glacier track is unmistakable, the striations pointing N.E., S.W., and it immediately borders a pre-glacial land surface. Singularly enough the glacier has spared this portion of the surface, so that the channels and basins dissolved by rain water still remain much as they were before the glacier encroached on the neighbouring surface. To those who are still doubtful as to whether glacial striations are the work of stranding icebergs or of land-ice, it would prove a useful exercise to measure the inches of hard limestone rock that

have been planed off the surface near the boundary of the two denudations. This is the only locality that I know of where such a measurement is possible.

At the base of the outer breakwater, Port St. Mary, the glacial striæ point 30° N. of E.; this is a little more easterly than those at Scarlett. Notice here and at various points further along the southern shore, how often the edges of limestone strata have been bevelled. The striæ are still visible, and very often run horizontally along the vertical faces of the shelves. Some small domes, 2-3 feet across, like miniature volcanic cones, appearing in the limestone close by the kilns, are very unusual features. Any one who could explain their origin would confer a benefit to our science.—I. E. G.

NOTES.

Month after month we have presented to us a number of Journals, &c., from kindred Societies, and Papers by workers in the geological field, which are deserving of more notice than they sometimes receive.

This month we are favoured by Mr. G. H. Morton, F.G.S., with a copy of his Presidential Address to the Liverpool Geological Society, on "Local, Historical, Post-glacial and Pre-glacial Geology," which has a special interest to our members, as being a contribution to our own discussions on the Valley of the Mersey. The Author quotes a number of authorities who have written on the subject, and, tersely passing judgment upon them severally, briefly states the conclusion at which he has arrived to be, that a clear distinction must be made between the Mersey as a river and as an estuary: "there does not seem to be any reason for supposing that the River Mersey ever ran into the sea at any other place than its present mouth," but that "the Estuary of the Mersey is a comparatively recent arm of the sea, and may have only assumed its present form and importance since the Roman occupation."—D. C.

*** *Other notices will appear next month.*

ORDINARY MEETING

Held at the Free Library, Monday, May 7, 1888, Mr. C. Potter in the Chair.

ELECTION.—Miss K. Meek.

NOMINATION.—Mr. Richard H. Ashley. 15, Stanley Street.

EXHIBITS.—Green Selenite from Chili, exhibited by Mr. R. Williams. Rock specimens to illustrate Mr. George's paper, by Mr. Hornell and Mr. George. Cumberland Minerals, by Mr. Brown, to illustrate his paper. Sectional drawing of Well Boring at Burscough Station, exhibited by Mr. Potter, and presented to the Association.

Papers on the following subjects were then read :—

A DAY'S WALK COLLECTING MINERALS IN CUMBERLAND.

BY JOSEPH BROWN.

Taking Keswick as our starting point, and being up at six o'clock in the morning, we provide ourselves with a wallet well filled for the day's requirements, two good hammers and chisels, and, with strong stick and a stout heart, we take the road leading towards Skiddaw. By and by we arrive at Roughten Gill, rather a romantic place, where a mine is worked for lead and copper. Starting to work in the ordinary way amongst the rubbish thrown out of the mine, we may hope to make a fair collection of copper and lead minerals. Our list may include the following :—Caledonite (sulpho-carbonate of lead, and carbonate of lead and copper); Calamine (carbonate of zinc); Brochantite (hydrated sulphate of copper); Mimetite (arseniate of lead); Smithsonite, or blue zinc (silicate of zinc); Linarite (sulphate of lead, with oxide of copper and water); Malachite (a green hydrated carbonate of copper); Witherite (carbonate of baryta); and a few others.

Leaving Roughten Gill we pass on to Dry Gill, rather a comical situation for a working. Here we find the beautiful mineral Kampylite (phospho-arseniate of lead), rather a rare species, occurring in a dirty-coloured quartz, mixed up with Manganese. After exploring this ground as long as time will allow, we depart for Carrock. Here we find a very romantic rough looking mountain, with a great variety of rock-material thrown into many different shapes. At the bottom of a small ravine we find a mine worked for Wolfram.

To the left hand, leading up the mountain, we next find a quartz vein appearing at the surface, with a width of about four or five feet. This is the place where the work is to be done. The quartz will now have to be attacked in good earnest, being a stout foe. Hammers and chisels we shall find plenty of work for, but we shall be well repaid for all our labour. The contents of the quartz vein include splendid quartz crystals, some as clear as glass, others smoky or straw-coloured; Molybdenite (sulphide of molybdenum); Telluric Bismuth (tetradymite); Native Bismuth; Mica, fresh and decomposed; the latter being what the old mineralogists styled Nacrite; Wolfram (a tungstate of iron); Scheelite, a rare mineral (tungstate of lime); Manganese oxides; Apatite (phosphate of lime) in various colours; and possibly a few more species. Close by, we shall also find a fine black Tourmaline (schorl).

But by this time we must be thinking of moving towards home. Passing along the foot of the mountain to the right hand we work our way up the watercourse, until finally we find ourselves at the spot where we began to ascend the mountain for Roughten Gill. And now we proceed along our previous track through Skiddaw Forest, until we cross the watershed. Then following the left bank of the river, we keep a sharp look out for crystals of cap-quartz. Soon we reach an old copper mine where we may expect to find some splendid specimens of Aragonite (carbonate of lime), some of

the crystals as fine as needles. These will be found, along with Malachite, in a mass of dirty quartz. After spending a little time here, we may strike up Saddleback mountain, where we again find Manganese. We shall also see a fine section of Gneiss with intrusive veins of Granite. Now following the river downwards through Brundholme Woods, on the side of Latrigg mountain, we reach the Penrith road after crossing the stream. Turning to the right, we soon reach Keswick, no doubt well tired out, but amply repaid for the day's work.

ON THE COLLECTION OF ROCK-SPECIMENS.

By Isaac E. George.

I remember on one occasion receiving from some young friends, non-geologists, just returned from a sea-side holiday, about twenty pieces of rock gathered by them on the beach and roadside; they were supposed to be representative of the district visited, and so of interest to a collector. Needless to say, they were not of the slightest use; they contained no fossils, and those of them which had not been exposed to the air long enough to get quite rusty and decomposed had been battered about on the beach sufficiently to eliminate all traces of their structure. But the most serious fault of all was that the rocks had not been seen *in situ* by the one whose collection they were intended to adorn. In chronicling the failure of a well-meant effort, I have indicated what will generally be considered necessary in a rock specimen,—cleanness of fracture, freedom from weathering, a certainty of its being representative of the mass to which it belongs, and a general knowledge of its surroundings.

But while these conditions will apply to most cases where a collection of rock species is aimed at, they will, perhaps, not be applicable at all in that larger sphere of work which embraces the selection of varieties indicating some particular structure or appearance. For this class of work no general rules can be laid down. By all means, never neglect an

opportunity of adding a new species to your cabinet, and do not leave a rock where you may notice some new structure, until, if it be practicable, you have secured an illustrative fragment. The number of structures to be met with in rocks is endless, ranging from amygdaloids to slickensides, and from sun-cracks to glacial striæ, and no thorough knowledge of geology is possible unless the closest attention has been paid to these. Most of the remarks I have now to make will apply mainly to the aqueous rocks, and it appears to me that cabinet specimens may be collected to illustrate most of the following points in the history of this important group.

CONDITIONS OF ACCUMULATION.—Deep water, or water free from suspended matter, shown by limestones. Shore conditions indicated in sandstones and shales by rain-prints, worm-burrows, footprints and sun-cracks. Disturbed areas of sedimentation, characterised by conglomerates and coarse sandstones, and by current-bedding; quieter areas, by fine-grained sandstones and shales. Salt-lake conditions, apparent in paucity of life, development of gypsum and rock-salt, with casts of salt-cubes.

CHANGES UNDERGONE SINCE ACCUMULATION may be illustrated in endless variety. The stages of induration and metamorphism, from soft sands, mudstones, and limy ooze to quartzites, slates and schists, gneisses, and marbles. The development of slickensides and contortions. Joints passing through pebbles. Material occupying fissures and cavities. Development of flints, nodules, and septaria.

SOURCES FROM WHICH SEDIMENT DERIVED.—Conglomerates containing rocks and fossils derived from pre-existing rocks. Boulder clays, containing specimens from very wide areas.

The foregoing are some of the subjects which a collection of rock-specimens may be made to illustrate. I have not by any means exhausted the list, nor have I dealt with any but aqueous rocks, leaving out of question, as worthy of special treatment, the great group of igneous rocks.

It will be found that whilst fresh rock-species may be collected in quarries, it will not be possible to get many illustrations of structure there. Most of the physical characteristics of rocks are only rendered apparent after long exposure to the weather, so that our best collecting grounds in this connection will be the exposed cliffs, the talus heaps, and the rocky seashore where the face of the cliffs is only played upon by the light spray. The talus heap is specially worthy of examination, as it frequently furnishes samples of all the varieties of rock outcropping on the slope above. Some of these outcrops might prove to be grass-grown at the time of your visit, and so the existence of the rocks might not have been suspected, but for the tell-tales below.

Your cabinet specimens then, will at all times be prepared to discourse most eloquently to you concerning the wonderful phases and events of Geological history; but if you have been an intelligent collector—and I think that is the case—they will have a something to say to you in addition to all this, a something which is audible to your own ear alone. That piece of conglomerate speaks of a time when the foundations of Snowdon had not been pressed into slate; when mountain masses of rhyolite and felstone reared their crests hard by, and the great mass of Archæan land loomed dimly in the far north-west. But you forgot all this as you pocketed your specimen and turned round to admire the delightful green canopy of sycamore which overhung the rocky gorge in which you stood. You had leisure then to examine a waterfall, the roar of which had been the only thing audible as you applied your hammer to the rock. You wondered what could be the depth of that eddying pool at your feet, and whether anyone ever heard just such music in the waters as greeted your ears. You collected yon fragment of granite on a rugged slope not far from the Land's End. Its outer coating of lichen you will probably never feel inclined to remove. That hoary incrustation is to you what the magic spy-glass was to the Persian prince, enabling you to see what is going on in distant parts

of the earth, and to place yourself at once in sympathy with scenes dearest to your heart. You live over again the healthiest moments of existence, and see once more the majestic contour of the granite bosses lightly draped with silvery lichen, to which you thought the patches of yellow gorse on the distant slopes formed a very fitting background. The invigorating sea breeze that fanned your cheek had passed over the distant Scilly Isles, and as you sought to carry your mind back to that far distant period when dry land extended from island to island, you were as hopelessly lost as you are now that you glance at your rock-specimen, and try to reflect on the immense changes that the earth must have gone through since those remote ages when the granite of Cornwall finally solidified under an immense weight of material. You know well that there can be no permanent pleasure without toil; but I think you will also have discovered that when the study of Nature is the object, and the work can be carried out under the bracing circumstances which I have indicated, there can be no toil without pleasure.

Donations to the Library, and Exchanges. — Annual Report of the Free Library Committee, Birmingham, 1887; Annual Report of the Free Library Committee, Liverpool, 1887; Journal of Liverpool Astronomical Society, vol. vi., part 5; Annual Report of Lancashire and Cheshire Entomological Society, part 3, 1886-7; Abstract of Proceedings of Geological Society of London, parts 517, 518; Annual Report and Proceedings of Belfast Naturalists' Field Club, 1886-7; Transactions of Manchester Geological Society, vol. xix., parts 16 and 17; Gold Fields of Victoria, Quarterly Report, December, 1887; Proceedings of Geologists' Association, London, vol. x., part 4.

NOTES.

An interesting addition to our Library is the Inaugural Address of the President to the Society of Amateur Geologists of London, by William Semmons, M.M.S. Some of his words

of wisdom contained in this pamphlet are worth repeating:—

"As Amateur Geologists we are banded together to compare notes and learn from one another something of those pleasant surprises which are always in store for seekers after Dame Nature's secrets."

"Busy by day in the turmoil of this bustling city, we have but little time to follow any phase of our gigantic subject in its latest developments; we, therefore, invoke the aid of one and all to help us, each with his little store adding to the common wealth. We feel that we can thus advance our knowledge, and consequently our pleasures, by receiving papers on special subjects that give information to most of us though they can hardly be called original."

Mr. Semmons being thoroughly conversant with the *Mineral Deposits of Cornwall*, has taken that as the subject of his Address, and finds it a very wide subject, yielding, as it does, "at least 300 distinct species of metallic minerals," upwards of 60 of which he names, and finds time to say something about each.—D. C.

A bulky annual volume (No. 7) just received from the Liverpool Engineering Society, contains amongst other valuable matter, a paper on "Tidal Works on the Seine and other Rivers," by J. N. Shoolbred, which possesses great local interest as it deals largely with the Physiography of the Mersey Estuary.

An address by Professor Williamson on "The Fossil Trees of the Coal Measures," which specially epitomises our present knowledge as to the nature of Stigmariæ, appears in the monthly part of Vol. xix, of the Manchester Geological Society's Transactions, recently added to our Library.

Amongst the names lately added to the roll of the Geological Society appears that of our President.—I. E. G.

Owing to one of the Analyses being still incomplete, Mr. Gray's paper on "Wolframs," will not appear until next month.

A TRIP TO LANGDALE.

Our Whit-Monday excursion to the Lake District took us rather out of the beaten track, and proved all the more enjoyable on that account. Driving north from Windermere, and working round the lake to Clappersgate, our route lay along the Little Langdale to its upper end, and then back through the Great Langdale. Both valleys are deeply excavated in the massive lavas and tuffs of the Borrowdale series, which are intercalated to the thickness of about 12,000 feet between the Skiddaw Slates and the Coniston limestone of the Lower Silurian. The rugged outlines and precipitous slopes always associated with this series are seen to great advantage in ascending Little Langdale, where they give rise to a series of waterfalls. But the great interest of this upland valley lies in the evidences of glaciation visible on every hand. Numberless hummocks of rocks have been powerfully affected by the movement of the old glaciers, their tops being flattened or rounded, and their steeper faces looking down the valley. On one crag by the head of the valley are seen resting a large number of rounded boulders, evidently "perched blocks" left there by the glaciers. Moraine rubbish is plentiful, the round boulders being imbedded in a stiff red clay. From the culminating ridge at the head of this valley, the mountain road leads steeply down into Great Langdale. Here may be seen some fine moraine heaps below Rossett Gill. The magnitude of the lofty tract which, during the glacial period must have formed the great collecting ground for the ice of the Langdale glaciers, can scarcely be appreciated from the foot of the Fells, but viewed from a distance of 10 miles it becomes more apparent. Bow Fell, Sca Fell, and the Langdale Pikes rise from this elevated tract, and the Langdale shared with Wastdale and Borrowdale the ice shed from their slopes. The numerous small lake basins below give one the impression of having shrunk very much through the deposition of alluvium at their upper ends, and some of them cannot now be more than one-fourth their former size. For the success which attended the excursion, great credit is due to Mr. T. S. Hunt, our leader for the day.

ORDINARY MEETING,

Held at the Free Library, Monday, June 4, 1888, Mr. T. R. Connell in the Chair.

ELECTION.—Mr. Richard H. Ashley.

NOMINATION.—Mr. E. Poston, Grierson Street, and Mr. J. L. Eills, 45, Croxteth Road.

EXHIBITS.—Specimens of Gold Ore from Transvaal, exhibited by Mr. E. Dickson, in illustration of his paper. Gold Quartz from Wales, exhibited by Mr. Dickson and Mr. Maguire. Several Pseudomorphic Fossils in Pyrites, by Mr. J. Hornell; Crystals of Copper Pyrites and Pearl Spar from Laxey; peculiarly-weathered Limestone and Fossil Polyzoa from Ronaldsway; Mammalian Remains from Hango Hill; and a Flint Scraper of Early Neolithic character from Port-e-Chee, exhibited by the Secretary.

DONATIONS TO THE LIBRARY, AND EXCHANGES.—Abstract of Proceedings of Geological Society of London, parts 519 20-1-2-3; Report and Proceedings of Manchester Scientific Students' Association, 1887; Transactions of Manchester Geological Society, vol xix., parts 18 and 19; Proceedings of the Geologists' Association, Feb. 1887; "Tidal Action an Agent of Geological Change," and "An Estimate of Post-Glacial Time," by T. Mellard Reade, F.G.S., presented by the Author; The Geological Record for 1879, presented by the President; Report of the British Association, 1887, presented by Mr. J. C. Evans.

A SKETCH OF THE GEOLOGY OF THE TRANSVAAL, WITH AN ACCOUNT OF THE GOLDFIELDS, AND AN EXAMINATION OF SOME OF THE AURIFEROUS DEPOSITS.

BY E. DICKSON.

Considering the enormous area of the Continent of Africa, there is a remarkable want of variety in the formations represented. Granitoid and Metamorphic rocks (supposed to

represent the Archæan rocks of Europe and America), appear from beneath the Cretaceous strata of Egypt and the Soudan and the more recent rocks of Abyssinia and are supposed to be extensively represented in the interior. They are also found extensively in the south, and on the east and west sides bordering the ocean. Silurian rocks are (as far as it is known), absent from the northern and central parts of the Continent, but occupy a large area in the Transvaal. Sandstones and shales,—resting on crystalline rocks,—supposed to be of Triassic age form vast plains (Karoos) in the centre of Natal.

Jurassic strata are entirely absent, as far as it is known, through the entire continent. Cretaceous strata (mainly limestones) are found in the northern part of the continent; and, in the south, beds of Shales and Sandstones with Cretaceous fossils rest unconformably on the Karoo beds. The Eocene period is represented by deposits which occupy large tracts in the Nubian and Libyan deserts, and supply the material (Nummulitic Limestones) out of which the pyramids are constructed.

Considering that the area of the Transvaal is equal to that of England and Ireland, the district is (even for Africa) peculiarly destitute of geological variety. The Silurian Rocks are represented by beds of Mica-schist, Clay-slate, Shales, and Quartzites, and cover a considerable area in the district, being found on the north slope of the Witwaters-Randt Range, which stretches over the whole breadth of the State south of Pretoria, and in the north, and as far west as the Marico district. In the Higher Marico district, the Clay-slates are overlaid by beds of limestone (supposed to be Devonian). What were known as the "Megaliesberg" beds, consisting of conglomerates, sandstones, and shales, and now classed provisionally as Devonian, rest unconformably on the Silurian schists and shales.

In the south and east the country is geologically poor, consisting of metamorphic rocks, "sedimentary rocks without fossils, and volcanic rocks without minerals." The Metamorphic rocks are of great variety (gneiss, mica-slate, clay-slate,

chloritic slate), and are frequently traversed by dykes, chiefly of diorite, forming a sort of "mantle" round a core of coarse granitic rock.

Patches of Sedimentary rocks are met with occasionally, but strangely destitute of fossils. To the north of Heidelberg at the mouth of the Zuikerboshrand River traces of ferns are to be found on layers of Sandstone. So again in latitude 23° 30′ S., and longitude 26° 40′ E., and in latitude 20° S., and longitude 29° E., sandstones are found containing remains of plants and various fossilized woods. With the exception of certain indistinct markings, supposed to be of graptolites, the Silurian Rocks are unfossiliferous. There are immense beds of coal found in the whole of the south eastern part.

The minerals found in the Transvaal are gold, copper, lead, cobalt, and iron.

It is remarkable that the quartz reefs are usually only auriferous when found traversing the metamorphic slates, whilst the reefs traversing the granite are usually barren of gold. The quartz itself is often very changeable in appearance and either compact or full of cavities. So the gold varies according to the place where it is found. Alluvial gold is found near Lydenburg with copper and iron pyrites, but there is a general opinion that alluvial gold will not be found in the district in payable quantities. Judging from the accompanying rocks with which gold is found in the Transvaal, the old mining saying that "gold is where you find it and silver is in veins" is verified, for it is found in various kinds of rocks, pure and in conjunction with other metals, and even no two tons of quartz run alike. The best known district where the gold bearing quartz is worked, is the valley of the Kaap River about 15 miles from Barbevton. Here the reef of quartz runs for several miles from south west to north east through granite and slate, and is intersected by dykes of diorite. The portion of the reef best known is the Sheba Hill, which has given its name to a portion of the reef itself. The rock is a massive quartz of a greenish grey colour. A speci-

men of this quartz has been examined chemically by my friend Mr. P. Holland, F.C.S., F.I.C., and microscopically.

Before being examined the quartz was crushed and the fragments examined with the lens, when bright yellow particles were seen. Some of the powder was placed in an open tube and heated, when S O_2 came off showing that pyrites was probably present. As it was wished to find out not only how much gold there was in the rock, but something of the character of the rock itself and the minerals associated with the gold, a section was cut and microscopically examined and submitted to Mr. Rutley, F.G.S. The crystals of quartz showed the irregular boundaries styled by Rosenbusch "allotriomorphous." Small patches, probably of felspar, and micaceous matter, probably muscovite, were seen to be present. An opaque mineral, either pyrites or gold, was present in the slide, partly in the form of irregular shaped grains and cubes, partly in forms with a six-sided outline. The colour of the Crystals was different from that of Californian gold, and no "scoring" of the surface of the crystals was visible, as would probably have been the case if they had been those of gold. Minute opaque crystals, which may have been of gold, were also present. There were numerous fluid enclosures in the quartz.

With regard to the chemical analysis, 10 grams of the quartz were taken to determine the gold present.

The weight of gold obtained from this weight of quartz was 2·9 milligrams, equal to 9 oz. 9 dwts. $11\frac{1}{5}$ grains per ton. The following are the numbers for the full analysis :—

SiO_2 - - - -	92·860
Al_2O_3 - - - -	2·860
Fe_2O_3 - - - -	1·220
FeS_2 - - - -	0·266
Au - - - -	0·029
MnO - - - -	——
CaO - - - -	——
MgO - - - -	0·180
K_2O - - - -	1·398
Na_2O - - - -	0·411
Combined Water - -	580
	99·804

It is also an interesting fact that a little carbon was found to be present in the quartz. During the last session of the Liverpool Geological Society, a paper was read by Mr. Holland and myself on the analysis of a quartzite from Nills Hill, Pontesbury, in which carbon was found; and in that paper certain observations were made on the evidence from which the conclusion has been drawn that the presence of carbon affords evidence of pre-existing vegetable life. It is, undoubtedly, a very important fact that carbon has been found in this massive auriferous quartz rock.

Recently another district of the Transvaal has been brought into prominence in connection with the gold discoveries. This district is known as the "Wit Waters-Randt," which means the Hill of White Waters, so called from the clear streams that flow from it. It is the name given to an undulating plateau, standing 6,000 feet above the level of the sea, and some 35 or 40 miles south of Pretoria. The circumstances under which gold is found in this district are altogether different to those under which gold is found in the Sheba Reef. The district, prior to the gold discovery, was a bleak, desolate moorland, containing only a few scattered farms, and did not carry on the surface the slightest symptoms of the presence of gold.

The plateau consists mostly of a loose quartz conglomerate, but which in places has the appearance of a compact quartzite. The reefs generally crop out two feet or so below the surface. The colour varies between a light yellow and a dark reddish brown. The appearance on arrival of the sample exhibited was that of a mixture of rounded water-worn quartz pebbles with angular fragments of quartzose sandstone, but with no sign of visible gold. The sandstone was composed of quartz grains mostly of the size of a millet seed. The remainder of the sample, which represented about fifty per cent. of the whole, consisted of coarse gravelly sand.

A chemical examination was first made of so much of the

sample as would go through a quarter of an inch mesh, with the following result:—

SiO_2 - - - -	85·720
Al_2O_3 - - - -	4·270
Fe_2O_3 - - - -	6·180
TiO_2 - - - -	0·115
MnO - - - -	0·025
CaO - - - -	0·010
MgO - - - -	trace
K_2O - - - -	0·227
Na_2O - - - -	0·318
Organic matter - -	0·290
Water - - - -	2·560
	99·715

The amount of gold from the sifted material yielded per ton 1 oz. 2 dwts. 16 grains.

The portion of the sample which would not go through the mesh and which consisted of the larger quartz pebbles (the largest quartz pebble weighed about 35 grams), was separately examined for gold, and gave 15 dwts. 3 grns. per ton.

These conclusions show that gold is found principally in the cement that holds the pebbles together, though not confined to it entirely. These parallel lodes of gold-bearing cement (called, from their resemblance to a sort of cake, "banket") have been traced in an east and west direction for 40 miles. It has been supposed that the Randt is an ancient sea-beach, and that as gold is a most widely distributed mineral and is present in sea water, that the gold has been deposited on a pre-historic beach in fine grains, and that ultimately the beach has been upheaved.

The reef dips 15 to 30 degrees to the south, and it is curious that reefs of pure quartz run along the same line and parallel as if an eruption had taken place at a later time.

Speaking generally, gold appears throughout the Transvaal in a variety of conditions. In one locality, the leaders of sider-

ideant quartz cut through shales, sandstone, and calcareous beds; but the gold was found with the siderite and not with the quartz. In another locality the leader cut through shales.

Gold is seldom found intimately blended with the quartz, and the veins are frequently filled with plates of gold.

In a third locality the quartz veins were filled with casts of pyrites, and permeated with dust-gold; and again in another locality, the gold occurred in flat pieces in breccia of sandstone shales penetrated by diorite; and in still another, the gold was found with bismuth in the heart of the quartz.

ON THE OCCURRENCE OF TIN IN CUMBRIAN AND OTHER WOLFRAMS.*

By George Watson Gray, A.I.C.

The word Wolfram, in the generic sense, includes a variety of ores containing Tungsten, Iron, and Manganese.

Wolframite, which is the commonest variety, is represented by the formula (Fe Mn) WO_4. The others are Hübnerite, Mn WO_4; Ferberite, 4 FeO $3WO_3$; Megabasite, 4 MnO 3 WO_3. Many specimens differ from these formulæ, the per-centage of Iron and Manganese fluctuating between 1 and 20; but this is not to be wondered at, since the composition of many minerals may be so varied by replacement, without any essential change in external characters, that such mineral species cannot be distinguished as compounds of definite radicals, but merely as conforming to certain general formulæ; that for Wolfram being $M(FeWO_4) + N(Mn\,WO_4.)$

Having had occasion to look up the published analysis of Wolfram ores, I find that they are very incomplete. This may be accounted for by the fact that the analysis is very tedious and difficult, Wolfram not having a wide application in the Arts and Manufactures; so that, for commercial purposes, the amount of Tungsten only is asked for, without noting other constituents.

One thing noticeable in the analysis is the occurrence of

* Read before the Association, May 7th, 1888.

the rare elements Tantalum and Niobium, and the absence of Tin. When we remember that Wolfram is found associated with Tin ore, it is only reasonable to expect that a little Tin will be present in the ores of Wolfram as an impurity, and this is really the case. I have analysed some dozens of samples from Cornwall and the Continent, and the percentage of Tin varies from 0·2 to 20·0, and I have not met with a single sample that was free from it. In the published results that give anything like a detailed analysis, Tantalum and Niobium are always present, varying in quantity from ·4 to 5·0 per cent.; but no mention is made of Tin. Without wishing to throw discredit on the analyses of the various chemists, I cannot help thinking that in many cases where Tantalum and Niobium were given, it really was Stannic Oxide. This compound is only soluble with great difficulty in acids and other solvents, and the greater bulk of the Tin remains as an insoluble substance, and therefore may have been set down as Tantalic and Niobic acids. Moreover, Tin is often associated with the ores of Tantalum and Niobium, the composition of "Tantalite" being Tantalate of Iron with small proportions of Tin and other bases. "Hielmite," Tantalate and Stannate of Iron, Uranium and Yttrium, and "Fergusonite," essentially a hydrated columbate of Yttrium, with usually a little Tin. (Collins' "Mineralogy," vol ii.)

This I take as further evidence of the probable presence of Tin in the before-mentioned Wolfram ores where none is shown by the analyses.

It occurred to me that it would be interesting to know if the Wolfram from Cumberland contained any of the rare elements or Tin. Accordingly, a piece of Wolfram was obtained by our Secretary, Mr. Clague, from Mr. Joseph Brown, a member of the Association, and, as most of you know, a personal collector in the district. Mr. Brown vouches for the genuine source of the sample. The sample gave on analysis 0·26 per cent. of Tin; but no trace of Tantalum and Niobium could be detected. I have also examined a second

ANALYSES.

	Cornish.	Locality not known.	Swedish?	Australian.	Indian.	Cumberland.	Commercial.
Oxide of Tungsten	74·00	48·79	70·99	74·70	73·15	..	70·85
Protoxide of Iron	6·20	7·05	7·84	19·20	13·19	..	8·24
Protoxide of Manganese	15·99	9·86	10·70	2·23	9·12	..	12·47
Alumina	1·40	3·47	3·29	2·97	3·24	..	2·23
Oxide of Chromium	Nil	0·13	Nil	Nil	Nil	..	0·26
Oxide of Titanium	Nil	Nil	Nil	Nil	Nil	..	0·17
Lime	1·24	3·29	2·06	0·16	0·04	..	0·74
Magnesia	Trace	Trace	0·10	Nil	Nil	..	0·06
Peroxide of Tin	0·30	25·39	2·10	0·40	0·40	0·33	2·26
Oxides of Tantalum and Niobium	Nil	0·60	1·60	0·10	0·20	Nil	Nil
Oxide of Copper	Nil	Trace	Nil	Nil	Nil	..	0·06
Oxide of Lead	Nil	Nil	Nil	Nil	Nil	..	0·02
Silica	0·70	0·90	1·30	0·20	0·40	..	1·85
Sulphur	Trace	..	..	Trace	Trace	..	0·09
Arsenic	Nil	..	..	Nil	Nil	..	0·03
Phosphorus	Trace	..	..	Trace	Trace	..	0·01
	99·83	99·48	99·98	99·96	99·74	..	99·34

sample, which I got direct from Mr. Brown, and this gave 0·20 per cent. of Tin; but no trace of Tantalum or Niobium was found.

I am not aware that Tin has been previously detected in any of the minerals in the English lake district. Probably, however, it may exist there in larger quantities, for its presence in the Wolfram is only accidental.

I append analyses of Wolfram ores from several localities. They are not complete, but are more exhaustive than any others previously published that I am aware of. In many commercial samples of Wolfram there are considerable impurities, and I have added an analysis which is by no means exceptional.

It is fitting that thanks be extended to the President, in whose laboratories the analyses have been conducted, and also to Mr. Swinfen Archdeacon for having examined many of the specimens.

NOTES.

It is worth considering whether the limestone breccia referred to on page 64 may not be of the nature of a *moraine profonde*, afterwards compacted by calcareous cement. Such accumulations of angular fragments of local rocks are common enough on the surface of the Trias in our own neighbourhood, and are always attributable to glacial action. I know of one such instance in the Carboniferous Limestone of Anglesey, and have no doubt many more will be found now that attention has been drawn to them.

July sees the first number of a local journal devoted to science. It will be issued monthly, under the title of *Research*, and from the fact that our President's name appears in connection with its management, we feel certain that the science of Geology will receive a due share of attention.

I. E. G.

EXAMINATION OF THE WATER FROM A SPRING IN ST. JAMES' CEMETERY, LIVERPOOL.*

By A. Norman Tate. F.I.C., F.C.S., &c.

In the course of his outdoor lessons to his students, last summer, our Honorary Secretary, Mr. D. Clague, visited the spring in St. James' Cemetery, and took samples of the water, which he afterwards brought to me, and these have been examined in my Laboratory, with the following results :—

In 100,000 Parts of Water.

Total solids, dried at 212° F.	82·000
Chlorine in Chlorides	5·800
Nitrogen in Nitrates and Nitrites	0·342
Free Ammonia	0·002
Albumenoid Ammonia	0·007
Oxygen absorbed in 15 minutes at 80° F.	0·034
,, ,, 4 hours ,,	0·081
Temporary Hardness.....	16·45 deg.
Permanent Hardness.....	33·55 ,,
Total Hardness	50·00 ,,

The Mineral Matters included in the Total Solids are :—

Carbonate of Lime	15·876
,, Magnesia.....	0·908
Sulphate of Lime	18·000
,, Magnesia	19·026
Nitrate of Magnesia	2·135
Sulphate of Soda	3·303
Chloride of Sodium	8·019
,, Potassium	1·708
Carbonate of Soda	1·378
Oxide of Iron and Alumina	0·800
Silica	0·200
Total (Anhydrous Salts)....	71·353

* Communicated to the Association, March 5, 1888.

It will be noticed that the water is exceedingly hard, and that the permanent hardness is fully double that of the temporary hardness. Chlorides are not exceptionally high for water from a sandstone district Magnesia as sulphate is in large proportion; but perhaps the most noticeable feature is the very small amount of impurity from organic sources. notwithstanding that the spring is in a closely inhabited district.

NOTES.

MANX CONGLOMERATES.—Bearing in mind the disputes as to the relative age of the conglomerate of the south of the island, I devoted some time and attention to the question on a recent visit. The conglomerate which passes below the Carboniferous Limestone I did not heed, as about it there is no dispute; but my attention was specially directed to the search for a clastic rock of more recent age. Nor was the search fruitless; for, on the shore at Ronaldsway, a short distance north-east of Derby Haven, I came upon a patch of calcareous breccia resting on the Carboniferous Limestone—the same limestone which rests upon the red conglomerate. The fragments composing the breccia are very angular, and show scarcely the slightest sign of having been water-rolled. Some fossils were found—one being a specimen of the *productus*, so common in the limestone beds of the district. The age of the breccia is, most decidedly, Post-Carboniferous—probably comparatively recent—as rough shingle, partly cemented by the deposits of carbonate of lime from water issuing from the limestone rocks, may be seen close by. Mr. Marrow drew attention to the recent formation of conglomerate at Strand Hall (Transactions, vol. vii., p. 57), and the same thing is noted by the Rev. J. G. Cuming ("Isle of Man," p. 137). The conditions and material for forming a calcareous conglomerate or breccia being at hand through all ages succeeding the carboniferous, it would not be at all surprising if conglomerates of various ages are discovered, now that local Geologists are devoting much of their attention to Manx geology. D.C.

ORDINARY MEETING,

Held at the Free Library, Monday, July 2, 1888. Mr. A. Norman Tate, F.G.S., President, in the chair.

ELECTION.—Messrs. J. L. Eills and E. Poston.

EXHIBITS.—Mr. W. H. Miles exhibited a rod of Sandstone from Storeton, about two feet long and three inches in diameter, the outer band of which was of a dark colour, and on the exterior bore marks which he supposed indicated its vegetable origin.

DONATIONS.—"Journal of Liverpool Astronomical Society," June, 1888; "Research," No. 1, presented by the Editor.

A Paper of which the following is an abstract was read by the Secretary.

"THE FLEXURES, FAULTS AND SLICKENSIDES OF THE NEW RED SANDSTONE."

BY D. CLAGUE.

My attention has been directed to this subject from the time when, conducted by Mr. T. Brennan, our members visited Breck Road, Wallasey, to study the remarkable contortions to be seen there, to the time when, rambling in pursuit of knowledge myself, or when out with students, I have been called upon to explain those contortions, &c.

* * * *

FIRST, NOTICE A FEW OF THE FACTS WHICH CALL FOR EXPLANATION:—

1.—A series of Crumplings which are overlaid by uncrumpled rocks, or from the upper surface of which there is clear evidence that material has been removed by denudation.

The section at Breck Road, Wallasey, may be regarded as typical of this set of flexure. In this section, cross-bedding is distinctly seen, and the principal crumpling occurs in a wedge-shaped mass of rock, which has the appearance of having been forced for some short distance between two masses of sandstone along the line of stratification. The wedge-shaped mass is split by a vertical fracture, four yards behind it a similar fracture appears in the next bed overlying it, and

two yards further to the south the uppermost beds shew a similar fracture—forming what has been termed a *lateral fault*. It is worthy of notice that even when most crumpled the rock is not indurated.

Similar sections are to be seen at Bidston, on Thurstaston Road from West Kirby, and other places, showing contortion in north and south sections. Contortions may be seen in east and west sections at Allerton Delph; McFall's Quarry, Bankfield Road, Green Lane; and at Thurstaston.

2.—A set of Flexures in the uppermost beds immediately under the Boulder Clay.

A good instance of this is seen in Mr. McFall's Quarry on the east side, where the outcrop of the rocks dipping southwards at an angle of about 40° are bent back to a vertical position, and at Thatto Heath a seam of coal with overlying clay is bent back so as to form a loop, and the broken fragments of coal carried for some distance amongst the broken clay.

Other Surface Crumplings are seen at Moor Hey, in the Keuper Marl. On the northern side of each set of contortion is found a hollow occupied by a stone, in some cases 4 to 5 feet in diameter, evidently belonging to the overlying boulder clay, and well packed in its place by the clay. A similar section was observed on a smaller scale some time ago at Eastham, the stone removed from its bed was only a few inches in diameter, and the crumplings caused by it did not extend more than a foot or so.

3.—A remarkable series of faults is found in the New Red Sandstone. A fault, it must be remembered, is not simply a joint, or crack in, but an actual displacement of the jointed or fractured rock.

A glance at a geological map of this district will shew that it is broken up by faults, indicated by white lines which traverse the country in all directions. The majority of them have a general trend of north to south, inclined a little to northwest, south-east. In the section shown from Hilbre to Huyton, no less than twenty faults are marked, and in addition

to these there are numbers more of secondary character, or step-faults, which are splinters from the greater faults with which they are connected. There are also many cross-faults trending in an east and west direction, these are comparatively short and quite insignificant when compared with the north and south faults.

Mr. Morton draws attention to the fact that many of the faults hade in opposite directions, forming trough or V faults, so that at some depth below the surface they would unite and therefore be fewer in number.—"Geology of Liverpool."

There is, however, another fact equally worthy of notice, that the lower beds have faults of their own, which do not appear at the surface, showing that the cause which produced the faults was at work during the Triassic period. One good section showing this was seen at Flaybrick Hill some time ago, but is now quarried away.

4.—Slickensides are polished surfaces of the rocks caused by friction as the rock face was rubbed against its opposite in the fracture at the time when the fault was formed, or subsequently, and being striated or scratched they give us a good general idea of the direction in which the rocks moved during the earth motions. In some cases the striæ are vertical, pointing to an up and down motion. These vertical striæ, it has been pointed out, are to be found in the faults which have a north-south direction, whilst in the east-west faults the striæ are either horizontal or oblique, indicating that the motion had been sideways. This must have resulted from a general sliding of the rocks throughout the district, some slipping away sideways, some sliding over the underlying rocks, and in some cases where the structure of the rock favoured the motion, a wedge-shaped mass has been forced in between two layers of rock, and when its further progress was impeded by the resistance offered, the same force that impelled it onward pressed it into smaller lateral compass, crumpling it in the manner in which we have seen many of those wedge-shaped masses are crumpled.

NOW, DO THE COMMONLY ACCEPTED THEORIES OF FAULTS AND CONTORTIONS HELP US TO UNDERSTAND THESE FEATURES IN THE TRIASSIC ROCKS ?

One set of writers attribute them to the rapid contraction of an inner hot nucleus of the globe, and consequent descent of the cool upper crust or shell, which being required to occupy a smaller horizontal space, must therefore suffer powerful lateral compression.—"Geikie's Geology," p. 315.

This refers clearly to the great folds which give us continents and oceans and, I think, indirectly affect the contortions and faults which we are studying. The same author says further, "On an inferior scale local compression and contortion may be caused by the protrusion of igneous rock." It is clear that the "contortions and crumplings" in the Trias rock are those of "the inferior scale," but they cannot be due to the protrusion of igneous rock, for the Trias rocks are singularly free from all connection with igneous action.

Other theories have been propounded, but as they assume such an increase of temperature as to produce, as in mountain chains, a considerable amount of Metamorphism, they cannot apply to our local rocks, which we have seen are not even indurated.

* * * *

Attention has been drawn to two sets of flexures, which are essentially different in character and in origin—some below, and some at the surface of the rock.

The terminal flexures and surface crumplings I attribute entirely to ice action. In each case observed, the force which caused them has moved from the north, which corresponds with the direction of the glacial striæ left on the surface of the rocks; the presence of the boulders from the boulder clay found in the hollows behind the crumpling indicates very clearly the instrument, and the force that impelled the instrument into the hollows and crumpled up the rocks. The other set of contortions, however, are of a different character, being at some distance below the surface of the rocks, and quite out

of the way of a glacier moving over the surface, and therefore cannot thus be accounted for.

* * * *

Seeing then that the ordinary way of accounting for these features in our local rocks is insufficient; before bringing in extraordinary agencies to account for them, or pushing the ordinary operations of nature to an undue extent, it would be well to CONSIDER WHETHER WE KNOW OF ANY EARTH MOVEMENTS THAT HAVE OCCURRED IN THE HISTORY OF THE NEW RED SANDSTONE ROCKS COMPETENT AND LIKELY TO BRING ABOUT SUCH RESULTS.

It is generally granted that our coal fields of the east and west were originally united, and that land tolerably flat and low lying extended from Cumberland and Lancashire on the one side, to Northumberland and Yorkshire on the other side, and that at the close of the Carboniferous period a crumpling of the earth's crust took place on a large scale, resulting in our country in the upheaving of the Pennine Chain in a somewhat sharp anticline on the one side, and of Ireland in a broader sweep on the other, North Wales being a portion of an intermediate ridge which extended along the Irish Sea, at least as far as the Isle of Man; whilst South-west Lancashire, Cheshire, and neighbouring Triassic counties formed the syncline in which the material eroded from the crest of the anticlines was deposited, forming the Permian and Trias, or New Red Sandstone deposits.

Great earth movements we know are proverbially slow, and it is not too much to suppose that the one which threw up the Pennines, and formed the great Pennine fault, having a throw of from 3000 to 6000 feet, was so slow as to continue all through the Permian and Bunter ages, and perhaps pass on far into the Keuper, during which it was probably arrested by another movement which led to the formation of the Lias deposits. Now, if this be granted, and the earth movement be accounted for in the ordinary way, by the hardened crust accommodating itself to a contracting globe, then the New Red

Sandstone must have been deposited in a trough which was continually narrowing, as the anticlines and synclines were becoming more and more pronounced, in consequence of which, severe crushing from east to west would be set up between the two approaching anticlines, causing great cracks and dislocations roughly parallel to the Pennine Fault and at right angles to the direction of pressure; this we find to be actually the case. The great faults of our district having a throw of from 300 to 1200 feet, have the same general direction. This would, of course, relieve much of the strain to which these new rocks were subjected, but not all; for owing to inequalities in the strain, some portion would be pressed to and fro in an east and west direction, producing the faults having that trend, and the horizontal slickensides. This movement would set other masses in motion, in some cases causing a sliding of rock over rock, and in others, such a sliding of some wedge-shaped masses, having the apex in a line of stratification, in between two beds for a short distance; and, as a final exhibition of the spent energy, crumpling up, without indurating, rocks which it had no longer strength either to break or move.

This force being in operation from the close of the Carboniferous to the Lower Keuper period, will account for the varied fractures, faults, flexures and slickensides which abound in the New Red Sandstone Rocks.

In coming to this conclusion the fact must not be overlooked that the great amount of cross-bedding found, especially in the Bunter Rocks, helped in the work of sliding and crumpling by affording lines of weakness along which the rocks might be pushed, and at the same time produced those wedge-shaped masses which were ready prepared to be acted upon.

Nor need any doubt be thrown upon the hypothesis that sand slipping down steep banks would, in some cases, be crumpled to some extent, and so give the initial character to the contortion subsequently intensified. But as the theories which have been propounded as explanations of the local

Flexures, are some of them inappropriate, and others inadequate, and *as the earth movements which we know were in operation during the deposition of these rocks*, were quite adequate to produce the features to which attention has been directed, it is fair to assume that they were the causes of them, and our next study must be, so far as we can, to see what local causes may have existed for rock masses sliding in one direction rather than another, crumpling rather than fracturing, or faulting rather than crumpling.

NOTES ON MANX GEOLOGY.—*Continued from last month.*

SCARLETT STACK.—This rock has been described as a volcanic neck (Transactions vol. iv, p. 81; vol. viii, p. 25), and such it has always appeared to be when examined on repeated visits. On the occasion of my last visit, however, on passing out to the extreme parts at low-water, the stack was seen to resemble the basalt of Antrim, in that the upper part is compact and structureless, whilst that below has a decidedly columnar structure, the columns being four, five, and six sided, and almost vertical, the upper portions inclining a little to the north. These features indicate a lava *flow* rather than a volcanic neck, and also show that the lava flowed over ground which just there had a northward slope, it being an acknowledged axiom that the columns are at right angles to the cooling surface. The question then as to the site of the old crater or vent is still an open one.

These points were well noted by the Rev. J. G. Cumming, M.A., F.G.S., who says—"I have never been able to make out with certainty where the volcanic vent was that connected the trappean material first deposited, though I have conjectured that it was a prolonged chasm extending from the Stack of Scarlett into Poolvash Bay."—("Isle of Man," p. 123.) Again, on page 124, he says—"The view from the summit of the stack is very striking. We are standing on a pile of basaltic columns, not so magnificent or distinct certainly as those of the Giant's Causeway in the north of Ireland, but exhibiting the same characteristics." D. C.

JUNE EXCURSIONS.

OWENS COLLEGE, AND FLAYBRICK.—The field-work for the month was commenced with an excursion to Owens College, Manchester, on Saturday the 2nd, at the invitation of our honorary member, Professor W. Boyd Dawkins. On arrival at the College Grounds we were met by Mr. Percy F. Kendall, to whose watchful courtesy we were indebted both for the guidance and the explanations which helped to make our visit such an instructive one. In the grounds were to be seen numerous glacial boulders, including the giant erratic recently unearthed from drift deposits at Manchester. This stone was described by Mr. Kendall as a volcanic rock (Andesite), probably ice-borne from the Lake District. To the varied contents of the Geological Museum, its representative series of rock-specimens, its wonderful fossil-trees, petrological laboratory, &c., it would be impossible to do justice within the compass of our present notice; and probably the best way to show our appreciation of the collection, would be to take the advice given to us by Mr. Kendall, and repeat the visit as frequently as possible.

FLAYBRICK.—In our excursion to Flaybrick Hill (Monday the 11th), Dr. Ricketts drew attention to a lot of new features exposed during the course of recent quarrying operations. Especially good were those sections in which the junction of the Trias with the overlying glacial accumulations was shown. Moraine stuff, including large quantities of pipe-clay and angular blocks of red sandstone, all of local origin, rested on an irregular surface of the Keuper sandstone and underneath a quantity of boulder clay of the usual foreign character.

A note as to the composition of Pipe-clay may here be found useful. According to Page's "Economic Geology" (p. 185), an average composition may be taken as—54 Silica, 32 Alumina, and 12 Water, with traces of iron oxide, lime, and magnesia. It differs from China-clay in having a larger percentage of Silica.

JULY EXCURSIONS.

WALLASEY AND THURSTASTON.—That the features of these neighbourhoods lose none of their interest from being so frequently scanned, was evident from the keen discussion and earnest questioning that arose at each place as the exposures of Triassic sandstone were examined. The current bedding so well shown at Wallasey is reproduced at Thurstaston, and at both places the rounded grains of desert sand are seen to enter largely into the composition of the sandstones. Faults and lateral slickensides also abound in fair abundance, and show the great stress to which the rocks have been subjected. The intricate series of contortions so characteristic of the current-bedded sandstones of Wirral also seem to receive a larger share of our attention every year. The theory advanced before the Association this month by Mr. Clague, in his paper on the "Flexures, Faults, &c. of the New Red Sandstone," received very close attention on this occasion, the members having some of the typical sections before them for interpretation.

The escarpment of Keuper Sandstone at Thurstaston Hill, it was observed, trended pretty accurately in a direction at right angles to that of the main system of joints, so that one end of the shelf was higher than the other. The tabular masses into which the rock, both in front of and behind the great escarpment is divided, are not uncommon features in sandstones having a massive and regular jointing, though not found so finely developed elsewhere in the neighbourhood of Liverpool. Thor's stone, the most abruptly angular of these minor bluffs, affords a fine study in this direction.

FIELD MEETING AT HOLYWELL.

A Field Meeting was held at Holywell on Monday, Aug. 6th, 1888 (Bank Holiday), conducted by Mr. R. Williams.

Dr. Ricketts, F.G.S., assisted as demonstrator of Glacial Geology, and the Secretary as Palæontologist and referee on Mineralogy. The work commenced soon after leaving Holywell Station, at Greenfield which was observed to stand on an Alluvial deposit. Leaving Greenfield by Strand Road, a slight elevation in the ground indicated a passage from Alluvium to a harder rock, which proved to belong to the Middle Coal Measures. Here attention was directed to the ruins of the Old Abbey of Bassingwerk, interesting to the Antiquarian from its history; but its special interest to the Geologist consists in the curious and fantastic weathering of the stones of which it is built. These features were photographed by Dr. G. H. Webb and Mr. Cecil F. Webb, for future reference and study.

The passage from the Middle to the Lower Coal Measures represented here by the Gwespyr Sandstone and Holywell Shale was marked by a steeper ascent, and ground being rougher, our progress was slower, and climbing a little more difficult. This was, however, fully compensated for by the beauty of the scenery. Passing over the chert beds, representing the Millstone Grit, we proceeded to the White Limestone quarries near Pantasaph, which were found to be rich in Producta, Encrinites, and Polyzoa. On the way, a lead mine was visited, when the matter brought up from below ground was carefully examined.

Dr. Ricketts drew attention to the great quantity of Moraine matter which forms the surface deposit over a great portion of the district, and examination of the enclosed boulders showed many to be striated, and in some instances the striæ were interrupted by subsequent erosion.

The fossils secured included Productus Giganteus, P. Semireticulatus, and the Trilobite Phillipsia. Amongst the Polyzoa were Sulcoretopora parallella, Thamniscus Rankini, and (?) Polypora. Numerous corals and encrinite stems, and a few fish spines.

Amongst the Mineral specimens found were Calcite, both

in form of Nail-head and Dogtooth Spar, opaque and transparent, Amethystine and white, Aragonite, Phtanite, Banded Chert, Blende, light brown and bright yellow Calamine, Galena, Morion, and Umber.

ORDINARY MEETING,

Held at the Free Library, Monday, September 3, 1888, Rev. S. Gasking, B.A., Vice-President, in the Chair, assisted by Mr. I. E. George.

NOMINATION.—Mr. H. M. Wilson, 9, Lime Grove.

EXHIBITS.—Tray of Fossils, collected by Mr. R. Jackson from the gravel pits near Oxford, including Tooth of *Elephas Meridionalis;* Tooth of *Rhinoceras Tichorhinus; Scutella Subrotunda;* a number of Cretaceous Ammonites, and rolled fragments of Grypheas and Belemnites.

The Rev. S. Gasking also exhibited a series of Minerals and Rock Specimens from Canada.

A paper, of which the following is an abstract, was then read by the Rev. S. Gasking.

THE ARCTIC CURRENT AND FLOATING ICE AS FACTORS IN CANADIAN GEOLOGY.

In a voyage to Canada in the summer time, when the steamers take the shorter route through the Straits of Belle Isle, the attention of the geologist must necessarily be drawn to the agency of water in the altering of the earth's surface; water in the form of great oceanic or tidal currents; water in the act of freezing; water when congealed in the state of ice and snow. The temperature of the water becomes very low when the vessel gets into the Arctic Current, and soon many icebergs of every conceivable size and shape make themselves apparent. As the coast of Labrador is sighted, several large ones are seen stranded at different points; then round Belle Isle others are noticed, and the Straits seem to be lined by

them. These frozen masses come floating down from Greenland, and are stranded or driven into the entrance between Labrador and Newfoundland by the influence of the strong winds and currents. The student might profitably learn something about subærial and marine denudation by closely observing the various strangely-formed icebergs. In one, especially, an immense cave was hollowed out by the action of the waves, and presented a most interesting spectacle. At one end (the cave end) it rose to a height of about 300 feet, then it descended precipitously to a field just above the water-line, and at the other end rose to a height of say 50 feet, and appeared in the form of a triangle. Some of the bergs had huge pinnacles, and seemed to remind one of a cathedral; others were castellated, whilst a few were cliff-like in structure, and had a plane surface, and showed signs of stratification. These latter were scanned with admiring eyes. No doubt these interesting bergs were formed in the way indicated by Captain Wilkes, of the U.S. Exploring Expedition, who states that this peculiar structure is owing to the constant increase from the freezing mists over it. I can readily accept this explanation, as lying in a dense fog in the North Atlantic for some time soon shows the power of the intense cold, for it readily causes the mist to be frozen upon the rigging and other portions of the vessel. It is mentioned in books of geology that the icebergs carry large quantities of gravel and earth, and that frequently immense boulders are found floating on them. I have also read the accounts of several able scientists who have been on the look out for some verification of these oft-made statements, and they have asserted that, as far as their experience went, the icebergs were altogether free from stones and dirt particles. I am not unmindful of the fact that such Arctic explorers as Scoresby and Kane record the existence of boulders on bergs in the North Atlantic, Davis Strait, and Baffin's Bay; and I know that Lyell is willing to believe that he saw them on one occasion, and that one captain declared that they carry rocky

burdens of many tons weight. On the other hand, however, other voyagers in the *Challenger* and the *La Recherche* have witnessed no such ice—transported blocks. Wishing to make the most of the splendid opportunity presented, I carefully scrutinised every berg (and the number, I was informed, was phenomenally large) by the aid of a powerful glass, but failed to discover anything upon them. Since I returned home I have come across a statement of Dr. Bell in the Annual Report of the Geological Survey of Canada for the year 1885, which appears to throw a great deal of light upon the matter, and will, no doubt, reconcile the seemingly conflicting testimony. He says:—"We left Halifax on the 27th of May, and, after passing through the Gulf of St. Lawrence and the Straits of Belle Isle, steamed northward, near the edge of the ice-pack off the Labrador coast, to the entrance of Hudson's Strait, which we entered on the 16th June. Beyond the Straits of Belle Isle numerous icebergs were passed every day—both in the open water and among the field ice. When in the latter position they were observed to be always more or less completely surrounded by a space of open water. On the voyage back from Newfoundland to the Straits, between the 27th of July and the 3rd of August, icebergs were again equally numerous, especially as we approached the Labrador coast; but on neither occasion did we meet with any of remarkable size or height, the great majority of them being comparatively small. Towards the entrance of Hudson's Strait it was noticed that the bergs furthest out to sea or to the eastward carried stones, mud, or discolourations more frequently than those near the Labrador coast. We entered Nachvak Inlet on the 1st of August, and were informed by Mr. Skynner, who had been in charge of the observatory station there since the previous year, that the fixed ice of the inlet had only disappeared on the 12th of July. We afterwards learned that it had also cleared from Ashe's Inlet (near North Bluff), in Hudson's Strait, on the same day. Mr. Skynner informed us that the fixed ice extended only as far

out as 'The Breaker,' a rock at the entrance of the inlet. Outside of this the ice was moving with the winds and currents all winter. In the months of June and July wide lanes of open water were formed between the field ice and the land. As far as could be observed, this ice was clear, or free from dust and rock *debris*, as if it had been formed away from the land. The clear ice continued till the end of June, when foreign matter began to appear upon the slowly-moving floes. This, Mr. Skynner thought, was due to the fact that about that time the ice began to leave the adjoining shores, after having received upon its surface more or less rocky *debris* from the crumbling cliffs and slopes, or from having had earthy matter incorporated in it by freezing and by the action of high tides, such as those of the Ungava Bay. During the winter he found that the strong winds carried considerable quantities of dust and angular fragments of rock from the high cliffs and steep and loose taluses on either side of Nachvak Inlet out upon the fixed ice, and when it broke up in July, this material was borne off to sea. Toward the end of July all the field ice of the northern parts of the Labrador coast was discoloured or 'foxey,' and had a decayed appearance. The dust or mud with which it was covered was mostly yellowish and greyish in colour. Gravel, angular stones, patches of stony mud, and an angular boulder were occasionally observed." The remarks of Dr. Bell seem to be very satisfactory. I was off the Labrador coast in a dense fog on the 13th of July, and the steamer nearly collided with an immense iceberg in the early morning. At mid-day the mist cleared, and showed me that the vessel was surrounded by a vast number of these great perils to navigation. They were all so purely white that they must have been formed far up in the North in such a manner and at such a time that no rock *debris* could be carried away. Probably, if I were crossing now, there might be a likelihood of seeing some of the discoloured ice if steaming along the most northerly course. Evidently, the ice that breaks away first is purer;

then the later ice being nearer the surface of the land, receives the material before mentioned. The mud, stones, and boulders carried down, when the summer has advanced considerably, by the icebergs are deposited round the coasts of Labrador and Newfoundland, especially in the Straits of Belle Isle and on the Banks of Newfoundland. Thus the material peculiar to one locality is transported to another distant locality to form great beds, characterised by the incorporation of huge rock masses, stones, and earth in anything but regular proportions. In passing the southern coast of Labrador, I noticed that snow lay still upon the hills; but the fall must not be considerable year by year, for then glaciers would most likely form among the higher peaks. It is stated that along the northern coast there is no trace of glaciation upon the mountains, they all appearing to be very steep and serrated. Of course, in the fiords striæ are to be observed about the water-line, running parallel to the shores, and also piles of shingle matter forming terraces, caused apparently by the floe ice violently moved by winds and currents; but at a greater height no glacial action was discoverable. The mountains, as far as they were examined, seemed to show signs of being greatly affected by atmospheric agency solely, the freezing water being no doubt responsible for the disintegration of the rocks. Now, I am almost compelled to believe that the Arctic Current, bringing down, as it does, such an immense number of icebergs, has been a powerful factor in Canadian geology, although one's own leanings have been hitherto towards attributing everything to glacial action. It is in this way only that we satisfactorily account for the series of large North American lakes, the river St. Lawrence, the direction of the striæ on the rocks, and the presence of shells and boulders on the sides of the mountains. As regards the immense inland seas of Canada, this hypothesis only can account in a reasonable way for their excavation. Let me quote the words of Sir J. W. Dawson, in his excellent book on *Acadian Geology*, to show this most conclusively. He says:

"Ocean currents, if cold and clinging to the bottom, must cut out pot-holes just as rivers do, though geologists are too apt to limit their function to the throwing up of banks. The course of the present Arctic Current along the American coast has its deep hollows as well as its sandbanks. Our American lake-basins are cut out deeply into the softer strata. Running water on the land would not have done this, for it could have no outlet; nor could this be effected by breakers. Glaciers could not have effected it; for, even if the climatal conditions for these were admitted, there is no height of land to give them momentum." Dana contends that the bottom of the St. Lawrence is below the sea-level, even to some considerable way past the boundary to which the unmixed water from the Atlantic reaches; and he declares that during a progressive submergence the ocean could not possibly have any influence in cutting out contracted passages, except the narrow valleys had openings at each end to allow the powerful currents to run through. This objection, however, is met by Sir J. W. Dawson. He further states:—"If we suppose the land submerged so that the Arctic Current, flowing from the north-east, should pour over the Laurentian rocks on the north side of Lake Superior and Lake Huron, it would necessarily cut out of the softer Silurian strata just such basins, drifting their materials to the south-west. At the same time the lower strata of the current would be powerfully determined through the strait between the Adirondac and Laurentide hills, and, flowing over the ridge of hard rock which connects them at the Thousand Islands, would cut out the long basin of Lake Ontario and Georgian Bay. Lake Erie may have been cut by the flow of the upper layers of water over the middle Silurian escarpment; and Lake Michigan, though less closely connected with the direction of the current, is, like the others, due to the action of a continuous eroding force on rocks of unequal hardness." The excavating power of the cold ocean current was certainly considerable, and it would be aided greatly by the icebergs that it constantly

carried down, for these when grounded would, through the influence of floes sweeping rapidly by, be made constantly to whirl round, which would create large depressions and deepen existing ones, especially if some beds were more subject to wear than others. With reference to the striæ, there is ample information. It is reported that the prevailing direction of the scratches in the valley of the St. Lawrence is north-east and south-west. There is another set of groovings which take a course almost at right angles to the first series running across the narrow piece of land lying between Georgian Bay and Lake Ontario, then down the Ottawa Valley and over portions of the eastern townships. Sir J. W. Dawson is persuaded that the direction of the power which caused the scratches "was from the ocean toward the interior, against the slope of the St. Lawrence Valley," and this he considers fatal to the glacial hypothesis, and gives very strong countenance to the theory of ocean drift. He shows that a subsidence which would convert the present Canadian plains into sea, would necessarily affect the direction and flow of the Arctic Current over the old land surface, and its course would be from north-east to south-west, and as the cold stream would proceed up an incline, the ice which it carried along with it, would as it moved into water less deep, have a tendency to ground and so commence to scrape the bottom, and as the bergs wasted away, mud, boulders and shells would be left on high levels. When at Montreal I was eager to ascend Mount Royal to inspect the boulders found thereon. They are mostly Felspathic rock masses from the Laurentian range, and so have been transported thither, a distance of some 60 miles over a valley, from peaks of similar altitude. Floating ice alone accounts for the existence of these blocks in their present situations. Shells occur, according to Logan, on this eminence at a height of 430 ft. above the river. If we add 30 ft. to this we get the altitude above the level of the Atlantic, which is of great importance, for the place, exhibiting as it does the traces of a raised beach, may probably be, as he suggests, the

old ocean shore. You would, I know, like me to mention something with regard to the action of the ice in the river. It acts in two ways. In the winter, I am informed, on account of the small body of water covering the shallows and sand-banks, it is readily frozen into a huge mass which incloses a number of boulders lying about. These, in the spring of the year, are borne far away to other parts of the river. The ice works in this way on one side of St. Helen's Island. On the Montreal side, which is considerably deeper because of the great current that runs there, the piling and pushing of the ice is witnessed. At certain times, owing to ice blocking the narrow channel, the ice is packed in a strange way and becomes, on account of the intense cold, turned into a body of great thickness and solidity. This, when the river receives a sudden flood of water, is raised to an astonishing height, and is impelled onward with tremendous force, knocking over unprotected buildings or any other obstacles, and piling up the broken material on a high terrace, far above the ordinary level of the river. In conclusion, let me say, that the descent of icebergs through the action of the cold stream from the north, the freezing of bays and estuaries, the drifting and pushing of stones and boulders by ice can be seen on the Canadian coast in a way not possible elsewhere, and much matter is thus afforded for geological study to the resident or visitor as the case may be, and will convince either the one or the other that the Arctic current has had wondrous influence over the formation of certain parts of North America.

Donations and Exchanges Received. — Report of the Minister of Agriculture, Dominion of Canada, 1887, presented by Rev. S. Gasking, B.A.; Woodward's "Geology of England and Wales," presented by Mr. T. R. Connell; Abstract of Proceedings of Geological Society of London, 524, 526, presented by Mr. G. H. Morton, F.G.S.; "Stanilaw, Frodsham

and Ince Marshes," presented by Mr. G. H. Morton, F.G.S.; Thirty-second Annual Report of Birkenhead Free Library; Proceedings of Liverpool Geological Society, 1887-8; Report of Geological Survey of the United States, Vols. 4, 5 and 6; Quarterly Report of Gold Fields of Victoria; Report of Smithsonian Institution, 1885, part 2; Proceedings of Liverpool Naturalists' Field Club, 1887; Transactions of Mining Association and Institute of Cornwall; Proceedings of Geologists Association of London, May, 1888; Transactions of Manchester Geological Society, Vol. xix, part 20; Journal of Liverpool Astronomical Society, Vol. vii, part 1.

SPECIAL MEETING.

On Saturday, September 8th, a visit was paid to the works of Messrs. T. Jones & Co., Mount Pleasant, where the members were enabled to see and examine the various pedestals, panels, busts, &c., executed by that firm in fibrous plaster and Scaglioli, and to see the processes by which such choice results have been accomplished. The thanks of the Society are due to Messrs. Jones for their kind permission to visit their works, and to Mr. T. S. Hunt, who courteously and ably conducted the party through the establishment, pointing out and explaining the various details.

LIVERPOOL GEOLOGICAL ASSOCIATION,

FREE LIBRARY, WILLIAM BROWN STREET, LIVERPOOL.

Established 3rd June, 1880.

———:o:———

Council 1888-9.

President:

A. NORMAN TATE, F.I.C., F.C.S., F.G.S.

Vice-President:

T. R. CONNELL.

Members of Council:

Rev. S. GASKING, B.A., | J. BROWN,

D. CLAGUE, F.G.S. | T. S. HUNT,

J. K. DALE.

Treasurer:

J. HORNELL,
105A, Grove Street, Liverpool.

Secretary:

I. E. GEORGE,
11, Coltart Road, Liverpool.

The above form the Executive.

Librarian: E. EVANS.
Superintendent of Excursions: J. HORNELL.
Registrar: C. F. WEBB.
Honorary Lantern Demonstrator: B. CONLON.

———:o:———

Departmental Referees:

Palæontology	- - -	Rev. S. GASKING, B.A.
Microscopy	- - -	I. E. GEORGE.
Mineralogy	- - -	D. CLAGUE.
Chemical Geology	- -	THE PRESIDENT.

TRANSACTIONS

OF THE

LIVERPOOL GEOLOGICAL ASSOCIATION,

1887-8.

The TRANSACTIONS of the Association have been sent to the following institutions and societies, and exchanges received from those marked with a *.

*Australasia, Geological Society of.
*Barrow-in-Furness Free Library.
*Birkenhead Free Library.
*Birmingham do.
*Bootle do.
*Belfast Naturalists' Field Club.
*Burnley Literary and Philosophical Society.
California State Mining Bureau.
Canada Geological and Natural History Survey.
Chester Society of Natural Science.
Chester Free Library.
Cornwall Royal Geological Society.
*Cornwall Mining Association and Institute.
*Edinburgh Geological Society.
*Lancashire and Cheshire Entomological Society.
*Leeds Geological Association.
*London Geologists' Association.
London Geological Society.
*Liverpool Astronomical Society.
*Liverpool Engineering Society.

*Liverpool Free Library.
*Liverpool Geological Society.
Liverpool Literary and Philosophical Society.
*Liverpool Microscopical Society.
*Liverpool Naturalists' Field Club.
Liverpool Philomathic Society.
*Liverpool Polytechnic Society.
Liverpool Science Students' Association.
*Manchester Geological Society.
*Manchester Scientific Students' Association.
Norwich Geological Society.
North of England Institute of Mining and Mechanical Engineers.
*Nottingham Naturalists' Society.
Nottingham Free Library.
*Smithsonian Institution.
Southport Free Library.
*United States Geological Survey.
*Victoria Department of Mines, &c.
Wagner Free Institute of Science.
Warrington Free Library.
Yorkshire Philosophical Society.

Liverpool Geological Association.

ANNUAL REPORT.

SESSION 1887-88.

1st October, 1888.

During the past year we have elected 15 ordinary and 7 honorary members, our losses during the same period being 1 dead, 7 resigned, and 12 who have ceased to be members under Rule II. The present roll of members is 6 honorary and 110 ordinary members.

Ten ordinary meetings have been held, at which the following papers were read and discussed:—

"With the British Association in the Isle of Man," by the Rev. S. Gasking, B.A.

"Cave Deposits considered in Relation to Estimates of Time," by Rev. F. Ballard, M.A., F.G.S.

"Some Facts in connection with the Geology of the Mersey Basin," by C. Potter.

"The Birth, Growth, and Decay of Minerals," by A. N. Tate, F.G.S., &c.

"A Day's Walk collecting Minerals," by Jos. Brown.

"On the Collection of Rock Specimens," by I. E. George.

"On the Occurrence of Tin in Wolfram," by G. W. Gray, A.I.C.

"A Sketch of the Geology of the Transvaal," by E. Dickson, F.G.S.

"Flexures, Faults, and Slickensides of the New Red Sandstone," by D. Clague.

"Geological Notes on Canada," by Rev. S. Gasking, B.A.

Extra meetings were also held at the Museum, William Brown Street, for special study of objects to be seen there, as follows:—

"Life of the Pliocene Period," by I. E. George.

"Cavern Contents," by T. J. Moore, C.M.Z.S.

"Univalve Shells," by Rev. H. H. Higgins, M.A.

"Life of the Cretaceous Period," by Rev. S. Gasking, B.A.

"Life of the Eocene Period," by I. E. George.

In June we visited the Museum at Owens College, Manchester, and were courteously conducted through it by Messrs. Percy F. Kendall and J. R. Hardy, who explained to us the geological and zoological collections respectively.

Field work has been done at the following places:—

Ravenhead and Thatto Heath, under the guidance of the Secretary.

Langdale,	under the guidance of	T. S. Hunt.
Flaybrick Hill,	,,	Dr. Ricketts, F.G.S.
Wallasey,	,,	I. E. George.
Thurstaston,	,,	,,
Holywell,	,,	Richard Williams.

In September we visited the works of Mr. T. Jones, Mount Pleasant, to inspect his Scagliola imitations of Marble, Granite, &c., and the various applications of Fibrous Plaster to the ornamentation of buildings.

The Transactions of our Association for the year 1886-7 were completed early in the year, and copies sent to kindred societies and other institutions, from many of which we have received valuable contributions to our Library in exchange.

The Librarian reports the Library to be in good condition, the list numbering 120 bound volumes, besides a great number of pamphlets and exchanges, which are ready for binding.

The number of books issued during the year was 65; number of readers, 26.

Our thanks are again due to those members who have enriched the Library by making presents of books.

At the commencement of the year the Council appointed four members to act as Referees in the departments of Geological Study to which they had specially devoted themselves. To them members might apply for assistance in their studies.

This appears to have been a step in the right direction, the services of the Referees having been in frequent requisition.

Their Reports appear in the Appendix.

The Treasurer reports that he has cash in hand, £7 10s. 9d., accounts due from members for printing, £1 18s. 6d., and 25 Subs. £6 5s., out of which an account of £8 7s. 6d. remains to be paid, showing the Association to be in a sound financial position.

It is desirable that members pay their subscriptions promptly, so that the revenue of the Association may be at once devoted to the work in hand.

LIVERPOOL GEOLOGICAL ASSOCIATION, in Account with the Treasurer,

FOR THE YEAR ENDING SEPTEMBER, 1888.

Disbursements.

1888.		£	s	d.
September.	To Rent of Room and Attendant.....	3	5	0
	,, Printing and Stationery	9	7	6
	,, Postages and Incidentals.....	8	14	4
	,, Balance in hands of Treasurer ...	6	19	3
		£28	6	1

Receipts.

1887.		£	s.	d.	£	s.	d.
Sept.	By Balance from last Year ...				2	14	4
1888.							
Sept.	,, Subscriptions, viz. :—						
	110 Members at 5/-	27	10	0			
	3 Members paid in advance in previous years..... £0 15 0						
	25 Members in arrear 6 5 0						
	—			7 0 0			
	28						
	—	£20	10	0			
	82 Subscriptions for year 1887-8 ...				20	10	0
	2 ,, ,, 1885-6 ...				0	10	0
	8 ,, ,, 1886-7 ...				2	0	0
	4 ,, ,, 1888-9 ...				1	0	0
	96						
	,, Receipts from Members for Printing				1	11	9
					£28	6	1
	By Balance.....				6	19	3
	LIBRARY FUND.						
	By Balance as per last Account				0	11	6

Audited and found correct,

R. H. ASHLEY,
H. WESTCOTT, } AUDITORS.

THOS. R. CONNELL,
TREASURER.

LIVERPOOL, *28th September, 1888.*

APPENDIX.

CHEMICAL GEOLOGY.

During the Session I have received two specimens to report on.

One of them is a sample of Water from St. James's Cemetery, given me by Mr. Clague, our Secretary. On this I have fully reported in paper already published in the Transactions.

A further sample of a mineral found during an excursion to St. Helens has been submitted to me. The results of analysis are not complete, but shall be given early as a note for our procedings. A. NORMAN TATE.

REFEREE IN MINERALOGY.—REPORT.

My appointment as Referee in Mineralogy has, I am happy to say, brought me into pleasant contact with many of our members. A considerable amount of work had been done before it occurred to me that a Report of my work might be required, and therefore I kept no account of it.

Since keeping a record of Mineralogical work done I find I have examined and named upwards of 200 specimens of Minerals and Rocks for members and their friends, besides instructing others how to test specimens that could not be submitted to me.

39 Boxes of Minerals have been lent out, and I have been called upon to advise with 4 members who wished help in Geological Studies in their holidays.

Sept. 9, 1888. D. CLAGUE.

REPORT OF THE MICROSCOPICAL REFEREE.

The number of Microscopes contributed by members to the Association Exhibit at last winter's Associated Soiree showed what a large amount of material is available for

Microscopical work in our midst. About a dozen sections of lava were displayed to public gaze through the instruments, and thanks to the excellent performance of some of these and to the internal beauty of some of our volcanic rocks much gratification was expressed at the result. Most of the Microscopes possessed the disadvantages, so far as Petrological work is concerned, of high power and smallness of field, though some of the larger ones possessed, in the paraboloid lens, a valuable help to the study of crystal structure.

It was hoped that during the season several small series of rock sections would be circulated amongst our members for Microscopical study at home, but the means available up to the present time have not been sufficient to justify your Referee in launching such a scheme. It is felt, however, that the plan is one well calculated to create an active interest in Petrology, and to educate students up to the point where independent research becomes possible.

September, 1888. I. E. GEORGE.

LAWS

OF THE

Liverpool Geological Association,

ESTABLISHED 3rd JUNE, 1880.

OBJECT.

The object of the LIVERPOOL GEOLOGICAL ASSOCIATION is to promote the study of Geology and its allied Sciences.

RULES.

I.

That every Candidate for Ordinary Membership shall be proposed and seconded by two members of the Association, and balloted for at the next Ordinary Meeting; and the consent of three-fourths of the members then present shall be necessary for the admission of such Candidate.

The proposal shall be made on Form A, which must be filled up and lodged with the Secretary one week before the meeting at which the Candidate is to be proposed. The proposal form shall be submitted to the Council, and the Secretary shall report to the members any remarks the Council may deem it expedient to make thereon.

II.

Every Ordinary Member shall pay an annual subscription of Five Shillings, payable on the 1st October, or, in the case of a new member, within one month after election. Any member not paying the subscription within three calendar months, after being twice informed by the Secretary that it is due, shall no longer be considered a member of the Association.

III.

There shall be a class of Honorary Members, not exceeding ten in number, which shall consist of persons distinguished by their attainments in the study of Geology and its kindred sciences, or who have rendered valuable service to the Association.

Such Honorary Members shall be nominated by the Council and elected by a majority of votes at an ordinary meeting, and have all the privileges of Ordinary Members.

IV.

The Officers of the Association shall be a President, Vice-President, Treasurer, Secretary, and five other members, who together shall constitute the Council to manage and direct the affairs of the Association. Five to form a quorum. The officers shall be elected at the Annual Meeting to be held in October; retiring officers shall be eligible for re-election. Any vacancy occurring during the year shall be filled up by the Council.

V.

The Treasurer's Financial Statement shall be presented to the Association, with the Annual Report, after having been duly audited by two members proposed, seconded and elected at the last meeting of the Session.

VI.

The Ordinary Meetings shall be held on the first Monday in each month, at eight o'clock in the evening. The order of proceeding at such meeting shall be:—

1.—The ordinary business of the Association.

2.—Miscellaneous Communications.

3.—Original Papers or Communications, to be followed by discussion thereon.

4.—Announcement of business for the next meeting.

VII.

A Special Meeting may be called at any time by the Council; and they shall be bound to call such a meeting on

receipt of a requisition signed by not less than ten members, stating the purpose for which the meeting is to be convened. Seven days' notice of a Special Meeting shall be given to every member, such notice to specify the business to be considered; and the meeting shall be held within twenty-one days after the receipt of the requisition. No other business shall be considered at a Special Meeting except that for which it has been called.

VIII.

Field Meetings shall be held at places of geological interest, but none of the private business of the Association shall be transacted on such occasions.

IX.

The votes on any question brought before the Association shall be taken by a show of hands, except those for the election of officers and new members, which shall be taken by ballot.

X.

The manuscript of every Paper read, or a clear and legible copy thereof, written on foolscap, shall become the property of the Association, and shall be placed in the Library for the use of the members.

XI.

In case of non-compliance with the Rules of the Association, or misconduct by any member, such member may be requested by the Council to resign. Failing to do so, the Council may bring the case before a meeting of the Association, which shall deal with it as may seem expedient.

XII.

Every member may introduce a friend at any Ordinary or Field Meeting of the Association—provided, however, that no person qualified to become a member be admitted as a Visitor more than twice in the same year.

XIII.

No addition to, or change in these Rules shall be made except by a majority of not less than two-thirds of the members present at a Special Meeting to be convened for that purpose.

LIVERPOOL GEOLOGICAL ASSOCIATION.

FORM A.

M.....

.....

being desirous of admission to the Association, We, the undersigned, recommend h as a proper person to become a Member.

Dated.....18

Proposed by.....

Seconded by.....

Date Proposed.....

Date Elected.....

Signature of Candidate .....

.....Secretary.

REGULATIONS FOR THE ADMISSION OF ORDINARY MEMBERS.

RULE 1.—That every Candidate for Ordinary Membership shall be proposed and seconded by two members of the Association, and balloted for at the next ordinary meeting; and the consent of three-fourths of the members then present shall be necessary for the admission of such candidate.

The Proposal shall be made on Form A, which must be filled up and lodged with the Secretary one week before the meeting at which the Candidate is to be proposed. The Proposal Form shall be submitted to the Council, and the Secretary shall report to the members any remarks the Council may deem it expedient to make thereon.

RULE 2.—Every Ordinary Member shall pay an Annual Subscription of Five Shillings, payable on the 1st October, or, in the case of a new member, within one month after election. Any member not paying the subscription within three calendar months, after being twice informed by the Secretary that it is due, shall no longer be considered a member of the Association.

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